

# THE COAST ARTILLERY JOURNAL

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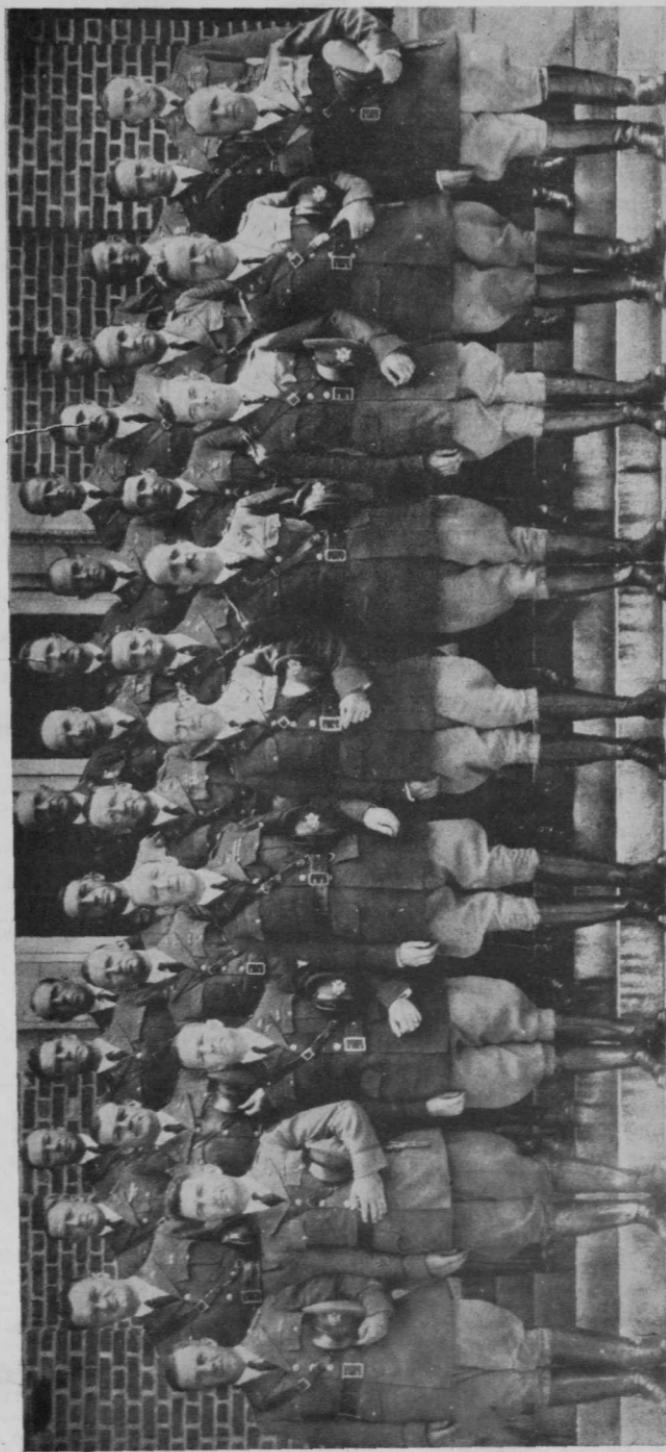
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# THE COAST ARTILLERY JOURNAL

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## G. H. Q. Artillery

By LIEUTENANT COLONEL EDWARD H. DEARMAND, F. A.

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THE idea of a General Artillery Reserve developed in the French Army during the World War: The 75-mm. gun, in which greatest dependence had been placed was found to be outranged by German field artillery; and the ammunition for the organic field types of artillery was practically exhausted. The result was a heterogeneous mass of cannon of all types for which ammunition existed, called forth from everywhere to serve with the field forces. Also, manufacture and development began of types better suited to field employment. An administrative headquarters for this unorganic artillery was established, and continued thereafter throughout the war. At first a division was made between army horse-drawn types and the tractor-drawn, the latter, only, being assigned to the Reserve. Later the horse-drawn types, also, were placed in the Reserve; and, still later, largely due to shortage of horses, some of the light field guns were made portée and gradually passed to the Reserve.

The mobility of this general reserve artillery was, except for a few units of portée 75's, the mobility of tractor-drawn units. The importance of strategic mobility in the reserve artillery was demonstrated by circumstances, especially in 1918. Today we are thinking of greater mobility, faster rates, and the G. H. Q. Artillery of our organization is limited to field types, those designed for maneuver. It is well to understand that many types to be found in the French war organization were entirely unsuited and out of place, but included under the urge of necessity.

2. In April, 1919, General Pershing convened a Board, which became known as the Superior Board, "to consider the lessons to be learned from the present war in so far as they affect tactics and organization."

The Superior Board recommended that there be no organic army artillery but, instead, a General Reserve of Artillery. In illustrating

the requirements of this General Reserve the Board took the situation offered by the Meuse-Argonne offensive of September 26, 1918, and, considering only the three corps west of the Meuse, the 1st, 3rd and 5th, the General Reserve thus figured was approximately 103 per cent. of the combined organic Corps and Division Artillery.

However, in forwarding the report of the Superior Board to the Secretary of War, General Pershing took occasion to observe:

The recognized ability of the officers who composed the Superior Board entitles their opinions to great weight. But I think that the work of this Board was undertaken so soon after the close of hostilities that the members were unduly influenced by the special situation which existed during our participation in the World War. Thus, in my opinion, the recommendations of the Superior Board are based upon the necessities of stabilized warfare in Western Europe rather than upon the requirements of warfare of the character and in the theatre upon which we are most likely to be engaged.

I present this quotation because, later, I expect to comment, somewhat, upon our present organization.

3. Prior to this, in December, 1918, the Chief of Field Artillery recommended the appointment of a Board, now generally referred to as the Caliber Board, "to make a study of the armament, calibers and types of materiel, kinds and proportions of ammunition, and methods of transport of the artillery to be assigned to a Field Army."

The Caliber Board recommended two types, a gun and a howitzer, each for the Division, Corps and Army. Progress in the development of these cannon will be discussed later. The Board, also, in a minority report, introduced the question of organization. This minority report, opposed the idea of organic Army Artillery and favored, instead, an Artillery Reserve.

4. In June, 1920, the Director, War Plans Division, W. D. G. S., organized a "Special Committee" to define the general plan of organization to be adopted for the Army provided by the Act of June 4, 1920." The report of the Special Committee, slightly modified by a memorandum submitted by the Chief of Staff, was approved by the Secretary of War on September 11, 1920.

In this approved report of the Special Committee provisions for Army Artillery and for G. H. Q. Artillery of the G. H. Q. Reserve were made as follows:

*a. Army Artillery*

Army Artillery Headquarters

1 ammunition train

(Also 1 Antiaircraft Brigade of 3 regiments, not classed as Army Artillery).

b. G. H. Q. Reserve (pro rata of artillery for *one* army).

G. H. Q. Artillery (pro rata for one army).

One Brigade † of light artillery, including:

3 regiments of 75-mm. (motorized)

3 regiments of 75-mm. (portée).

One Brigade of medium and heavy artillery, including:

2 regiments 155-mm. G. P. F. (motorized)

2 regiments 240-mm. howitzers (motorized)

1 regiment 6" guns (motorized)

(Also 1 regiment Antiaircraft Artillery and Machine Guns,  
not classed as G. H. Q. Artillery).

c. G. H. Q. Reserve (total of artillery for 6 armies).

G. H. Q. Artillery (for 6 armies).

6 Brigades † of light artillery, each of

3 regiments 75-mm. (motorized)

3 regiments 75-mm. (portée).

6 Brigades of medium and heavy artillery, each of

2 regiments 155-mm. G. P. F. (motorized)

2 regiments 240-mm. howitzers (motorized).

1 regiment of 6" guns (motorized).

1 regiment trench mortars

1 sound ranging service (10 S. R. companies).

1 regiment † 12" guns (railroad)

1 regiment † 16" guns (railroad)

(In addition, † but not a part of the G. H. Q. Artillery, there  
was G. H. Q. Antiaircraft Artillery and Machine Guns, con-  
sisting of 1 brigade of 6 regiments).

5. The major items shown above are still in force, except in two or  
three particulars:

a. The light artillery brigade of six regiments has been replaced by  
two light brigades of three regiments each (one brigade of motorized  
and one brigade of portée). This change, carried through to the G.  
H. Q. Artillery for six field armies, provides 12 light artillery brigades  
instead of the 6 listed above, but the same number of regiments.

b. The two regiments of railroad artillery provided in the G. H. Q.  
Artillery for 6 field armies have been withdrawn and are now allotted  
to Harbor Defenses.

c. G. H. Q. Antiaircraft Artillery is listed under the general heading  
of G. H. Q. Artillery.

These changes are carried in the approved War Department General  
Mobilization Plan.

<sup>†</sup>See: paragraph 5 for changes.

d. A fourth change worthy of mention here is connected with the organization of a Cavalry Corps, authorized by letter of the Adjutant General dated September 20, 1927. The only organic field artillery in the Cavalry Corps is the headquarters of a field artillery brigade. The following regiments of field artillery "may be attached to the Cavalry Corps from troops especially assigned or attached to the Army for this purpose":

1 regiment 105-mm. howitzer (horse-drawn).

1 regiment 75-mm. pack howitzers (or two regiments in case the horse-drawn 75's of the Cavalry Division are increased from a battalion to a regiment per division).

These units were not previously provided for, either in the Army Artillery or in the G. H. Q. Reserve.

6. As has been seen, the various Boards recommended in favor of a G. H. Q. Artillery, rather than organic Army Artillery. The Chief of Artillery, A. E. F., in forwarding the report of the Hero Board (the Artillery Board convened in the A. E. F. following the War), made the same recommendation.

The Chief of Field Artillery was less wedded to the plan as it was worked out, believing then, as now, that there was a need to think in smaller figures, and that a Field Army, considered alone, might very probably require a different quantity and different types than would be allotted, by percentage, to it as a part of a much greater force. However, the question was not of primary importance and he was not in a position to feel himself qualified to comment either from personal experience or from observation. Something of this thought will be presented for your consideration.

7. The Superior Board, for a field army of 12 divisions, organized into 3 corps, recommended an average of approximately  $7\frac{1}{2}$  regiments of field artillery, all types, per division. The recommendation was based upon a situation of the World War.

The Special Committee, for a field army of 9 divisions (smaller in size), organized into 3 corps, recommended an average of approximately  $4\frac{1}{2}$  regiments of field artillery, all types, per division. The approved recommendation of the Chief of Staff increased this by one regiment per division.

In each case the quota of G. H. Q. Artillery for one army was, obviously, a percentage of the great reserve mass, the mass needed as a reserve for a force of many armies. The larger project governed not only the proportionate distribution but also the types.

8. The types recommended by the Special Committee and given effect in our approved mobilization plans are, per army:

75-mm. tractor-drawn	(3 regiments)
75-mm. portée	(3 regiments)
155-mm. G. P. F.	(2 regiments)
6-inch gun	(1 regiment)
240-mm. howitzer	(2 regiments)

a. Organically, and aside from means of traction, the 75's of the G. H. Q. differ from the 75's of the Division in that the tractor-drawn regiments have no battalion combat trains and that the portée regiments have no battalion combat trains, have reduced ammunition, and no tactical mobility.

The tendency of thought with respect to the light field artillery regiments of the G. H. Q. is that they should have an organization essentially identical with that of the division field artillery regiment. For tractor-drawn units this would mean the addition of battalion combat trains. For the regiments now classed as "portée" the change would be greater; they would become essentially identical with the tractor-drawn.

The "portée" unit as originally discussed is not the portée of present thought. Then, the idea of strategic mobility overshadowed all others; a battery had but one tractor for the maneuver of its four guns, and hence had no tactical mobility; had but 60 rounds of ammunition per gun, and no reserve in the battalion or regiment. Plans were under way to increase tactical mobility but were uncompleted at the time of the Armistice. The portée was a type of special and limited employment, too much so, in the thought of today, for its maintenance to be justified.

While the Chief of Field Artillery has never been able to secure at his disposition a unit with which to carry on tractor-drawn and portée experiments, there are units organized as tractor-drawn and these units have done some experimenting in portée. In Hawaii, two regiments of 75-mm. are tractor-drawn, and in one battalion of one of these regiments portée has been extensively tried. The value of this work has been limited by a necessity of utilizing such equipment as was available locally. In Panama, the field artillery battalion has been made portée, but the organization was modified so as to provide sufficient tractors to insure tactical mobility. At the Field Artillery School one battalion of light field artillery is tractor-drawn, and recently one battery was hastily given the added transport required to secure portée mobility; marched to Marfa, Texas; maneuvered with the 1st Cavalry Division,

and marched back. With old trucks taken from the post motor-pool and equipment unnecessarily heavy, this column was able to average about 70 miles per day, with high runs nearly 50 per cent greater. The total load carried and trailed by a gun truck was about fourteen tons. The drivers, although qualified truck drivers, had had no previous experience in handling trucks so loaded.

The thought that I desire to present is that the light regiments of the G. H. Q. Artillery should be capable of the rapid movement which we term "strategic mobility" but should also possess the organization and mobility that would admit of their being attached to and maneuvered with division field artillery.

Later, I will refer to the progress made in developing the light field howitzer. This is a division type, with a mobility comparable to that of the 75-mm. gun. When available, it will deserve a place in the light field artillery of the G. H. Q. Artillery. This type, also, should be capable of both tactical and strategic mobility.

b. The 155-mm. G. P. F. regiments of the G. H. Q. Artillery have an organization identical in all respects with those of the corps. This gun is transported in a single load weighing upwards of 14½ tons. While lacking the mobility desired in the corps types, the units of the 66th Brigade, the only organic Corps Artillery Brigade which saw extensive and varied service in the World War, were maneuvered in a manner beyond all expectation. Progress in the development of a more suitable corps gun will be discussed later.

c. The 6" gun regiments have the same organization tables as the 155 G. P. F.'s. No units equipped with this type are maintained in our peace organization, and little or no knowledge is available. Due to the complication of types involved, the 6" gun is not looked on with much favor in the Field Artillery. As an Army type, its one great advantage over the G. P. F. is in range: 19,600 yards as against 17,700. One great defect is limited traverse; 8 degrees as against 60 degrees. The gun is transported in one load weighing about 12½ tons. There are but 150 of these guns, 99 carriages, and no ammunition. Many Field Artillery officers would be glad to have the G. P. F. substituted for this type.

d. The 240-mm. howitzer, like the 6" gun, is not found in the division or corps. It is the most powerful of the field types. Compared with the 155-mm. howitzer, its projectile weighs 345 pounds as against 95; its range is 16,400 yards as against 12,400; its traverse, when mounted on the firing platform, is 20 degrees as against 6 degrees for the 155-mm. howitzer; but the latter may be shifted by hand whereas a

shift of the former requires as much (or more) labor and time as an original emplacement. The 240-mm. howitzer is transported in four loads and requires five or more hours to emplace.

9. The employment of all field artillery is in conformity to the great plan of the higher commander. Each field artillery commander should be sufficiently informed of any action of other artillery which might affect his own mission. The allotment and employment of G. H. Q. Artillery are governed by the general plan: G. H. Q. allots to armies much or little of the available artillery in accordance with the importance and difficulty of each army mission. The units of the C. H. Q. Artillery, once allotted to an army, are employed in two ways: sub-allotted to corps in accordance with their requests, or the importance of their missions; or retained under army control. Corps in turn may sub-allot to divisions, or retain under corps control.

a. In general, if the unit is to continue under division or corps command throughout the engagement; *i. e.*, if it is to maneuver with the command to which attached, it should be of a type (light or medium) similar to that with which the command is normally equipped. This is not always practicable, especially with existing materiel.

If an attached unit is to serve a limited purpose not involving maneuver with the command, the question of type and maneuverability becomes relatively less important.

It is desirable that artillery fire employed on or in connection with division missions should be under division control; but storage in artillery may make such action impracticable. Artillery retained under corps control should have the range to execute corps missions beyond the division artillery zone, and no types should be retained under army control which have ranges insufficient to fire at targets beyond the corps artillery zone.

b. As I have said, the types employed directly under army control require great range so that they may be specially efficient at ranges beyond the outer limit of the corps artillery zone. While desirable theoretically, that they should have sufficient range and traverse to permit covering the entire army artillery zone at its inner limit, such a requirement is obviously impractical. But these heavier types, which cannot be traversed by means of shifting the trails, should possess the greatest possible traverse on the carriages.

The most suitable of the heavier field types in this respect is the 155-mm. G. P. F. which, with its 60 degrees traverse, covers a front whose width is approximately equal to the range. The 240-mm. howitzer, under most favorable conditions of mounting, is only about one-third as efficient in traverse: and the 6-inch gun, less than one-

seventh as efficient. The location and employment of all of these army types, under direct army control, are governed by the limited and specific missions which are to be assigned them. A single piece of neither of the latter two types can be traversed so as to cover a normal division front. A battalion (2 batteries) of 240-mm. howitzers, firing at 13,000 yards and emplaced so that the battery fields of fire do not overlap, could concentrate the fire of one battery over a front of approximately 8000 yards.

Of these two items, range and traverse, the latter is most frequently overlooked in problems. The units of the heavier types are so few in our peace establishment and their employment in problems so greatly limited to those affecting large commands that the technical question of the power of a weapon to accomplish all that is frequently required of it is seldom raised.

The fire of a single battery is the least that should be concentrated on an objective of any importance; preferably, it should be possible to concentrate the fire of a battalion. Using the regiment of 155-mm. G. P. F., of three battalions, it is possible to cover the front of an army of three corps (assumed as about 20 miles) and concentrate the fire of a battalion on any point of the army artillery zone. Three regiments of 240-mm. howitzers would be required to effect such concentrations. However, concentrations of less power and upon restricted areas may serve the need of any special situation. The location of battalions should, preferably, be in rear of the center of the sectors they are to cover, and with special reference to specific missions.

10. I have said that there is some question as to the soundness of the present provision of G. H. Q. Artillery. It is commonly accepted that as forces increase in size their powers of maneuver decrease. The division, if adequately supplied with field artillery for combat as a separate unit, should require some accession to its artillery power when its maneuverability is restricted through its being joined with other divisions into a corps. Our organization recognizes this condition and provides corps artillery. Similarly, the corps is restricted as to maneuver when formed with other corps into a field army. The lack of maneuverability develops increased frontal resistance and more extensive ground organization. A question apparently unanswered is that as to the amount of field artillery required by a field army operating alone. The amount given under the present organization based upon six field armies is not the answer, in my opinion, and I favor a

study of allotments to a field army when acting alone, and also of the somewhat different problems of the requirements of an army which is one of a group but which is facing normal conditions on its own front. It is relatively immaterial whether this artillery be organic or not; but probably organic army artillery, thus computed, would be better, with, in addition, quotas of G. H. Q. Artillery provided for various sized groups of armies.

In practice, the great G. H. Q. Artillery will be determined at the outset by the availability of materiel and ammunition. As an example, it is idle to depend upon the 6-inch gun, even to the extent of a single regiment, since there is no ammunition. Assuming that ammunition were available, we have carriages enough to mount the guns of only four regiments. The following table shows the requirements in field cannon for *one field army* and the status of materiel and ammunition for the various types:

Type	Requirements I field army	Number of guns and carriages on hand in U. S.	Ammunition on hand in U. S.
75-mm. Fr.	432	*3534 G. 3555 C.	4,000,000 shell 2,500,000 shrapnel
155-mm. H.	216	2978 H. *2096 C.	823,000
155-mm. G.	120	*794 G. 940 C.	93,000
240-mm. H.	48	309 H. *303 C.	1,700
6-inch G.	24	150 G. *99 C.	0
Pack H.	24	New materiel	
105-mm. H.	†24	New materiel	

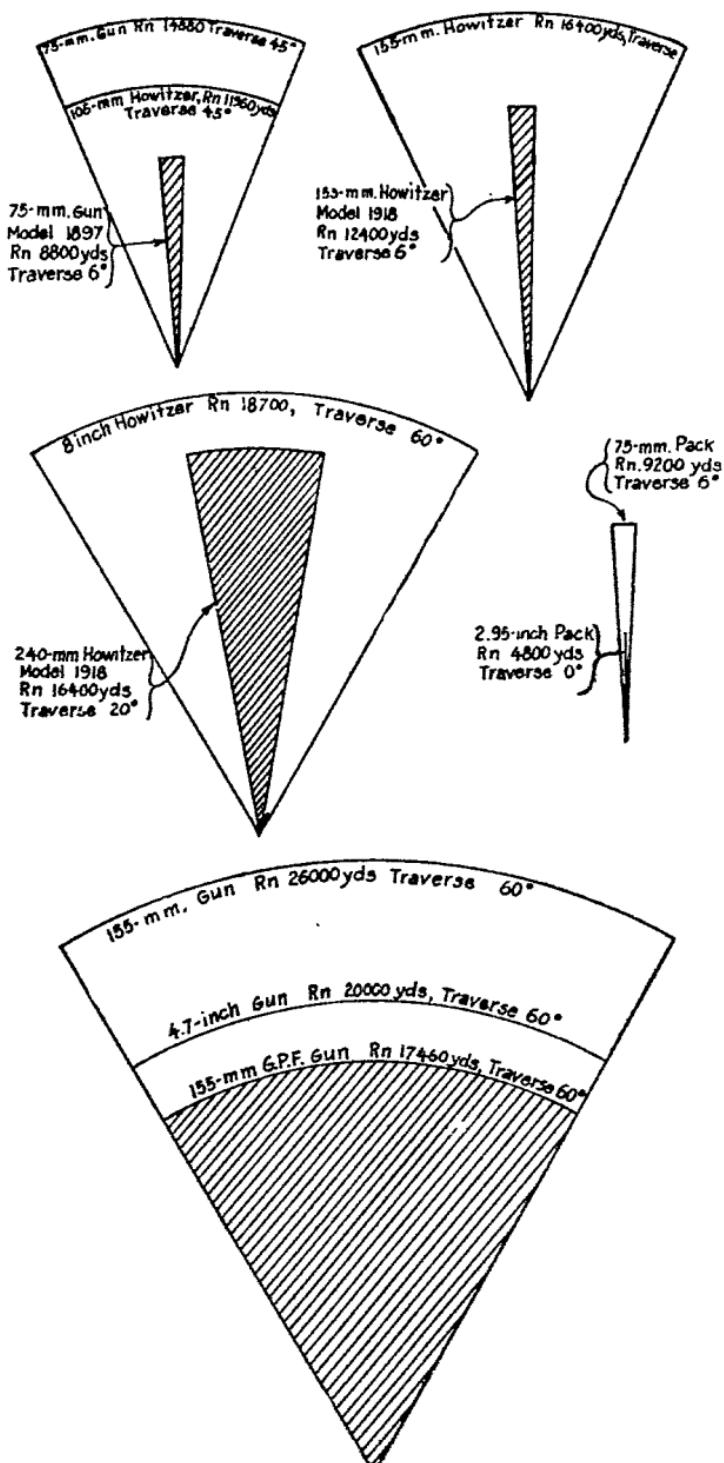
\*Limiting figure.

†Nine division regiments not included.

The requirement of six field armies in materiel may be met for all types except the 6-inch gun, and the two new types. The latter are provided for, in part, in the ten-year program. 155-mm. guns and 240-mm. howitzers in the hands of the Coast Artillery Corps are not included in the figures. The General Mobilization Plan requirements for seven 155-mm. gun regiments in the Coast Artillery Corps have not been considered for the reason that the field forces have precedent claim on the field types of cannon.

The ammunition on hand is fairly adequate for the 75-mm. gun; for the 155-mm. howitzer is equivalent to about twenty-five days of fire for the howitzers of one field army; for the 155-mm. guns, to about eight days of fire; for the 240-mm. howitzers, to less than one day of fire; and for the other types there is no ammunition.

The War Department has recently undertaken new mobilization studies based upon the limitations imposed by reduced strength and



A comparison of the areas covered by armament at present issued to troops with that of the cannone developed since the World War. Shaded areas represent present equipment. Traverse by shifting the trail is not considered in these figures. The 75-mm. gun Model 1897 and both of the Pack cannon have a rapid traverse by this means. The 155-mm. howitzer Model 1918, as compared to the heavier types, can readily be traversed by shifting the trail.

upon other practical conditions, and a single field army may be given increased importance in this study. It is apparent that the present organization is not in keeping with the requirement of a force for immediate employment.

11. Two items of the G. H. Q. Artillery have not been touched on: trench mortars and sound-ranging units.

a. It is somewhat difficult to say whether the trench mortar should be classed as an Infantry weapon or as Field Artillery. It is now assigned to the Coast Artillery. Many field artillery officers question the propriety of including the trench mortar in the G. H. Q. Artillery. It is a weapon of a very limited range of usefulness. As artillery, it would be better to continue development, so as to have designs available in event any emergency called for this type; but not to enter into production or even to provide units in the organized general reserve. Limited funds can better be employed in manufacturing more valuable field types.

b. Sound ranging is a valuable means of obtaining information of the location of enemy batteries and of improving the accuracy of field artillery fire. The Superior Board recommended that sound and flash ranging be combined in the Corps Observation Battalion. I am convinced that such is the proper organization. It is difficult to understand the motives which led the Special Committee to place flash ranging in the corps and sound ranging only in the G. H. Q. Artillery of six field armies. Recently a change has been proposed by the Chief of Field Artillery in the organization of an Observation Battery (a corps unit) which will combine in that unit both flash and sound-ranging functions. This should lead to an organization which will extend the scope of the Corps Observation Battalion to include Sound-ranging functions and probably eliminate the Sound-ranging Service from the G. H. Q. Artillery.

However, under present organization, there is no sound-ranging unit in the corps, or in the quota for one field army.

12. Before taking up the subject of progress in development of new and improved types of field cannon, it is well to refer briefly to the results which may be expected from field artillery fire.

In applying probabilities to the determination of the number of rounds required to give a desired effect, it is usual to assume an adjustment which places the center of impact in the target. Such an adjustment is surely practicable only when observation is possible. While some means of observation are better than others, it may be said that any means is preferable to none. Terrestrial observation will frequently fail even at the shorter ranges, and will rarely be possible at the longer.

In good weather the airplane is invaluable for observation of field artillery fire, but a recollection of the Meuse-Argonne will bring to mind many days when the use of airplanes was impossible. High burst and sound ranging are means which may produce good results. Otherwise, firing must be by the map, unadjusted.

It is not possible to say how much of the long-range fire of the World War was without material effect, but certainly such fire does not deserve the rather blind confidence with which its effect was credited. Of special interest in this connection is the study made of the army artillery in the St. Mihiel. Units which are sent in just prior to (or even during the night before) an offensive frequently are unregistered, of doubtful location, and ill-supplied with ammunition. An extended study of the probabilities of all elements affecting the accurate delivery of fire under such practical conditions of service is now being made by the Field Artillery Board. At the moment, little more may be said than that haste and lack of observation must be paid for with the ammunition required to search large areas.

13. Development in field artillery materiel since the war has been based upon the approved recommendations of the Caliber Board. The report of this Board is remarkable both for soundness and for vision. It has served as the guide of field artillery development in materiel for the past eight years. Requirements stated by the Board have from time to time been modified to meet the practical limitations developing from experience in manufacture and test.

Developments in field artillery materiel are always complicated by the two warring requirements, mobility and power. Field types must have mobility and they should have as much power as the mobility requirement makes possible.

a. The 75-mm. pack howitzer has been adopted for procurement, and units to equip two regiments have been included in the ten-year Ordnance Program. This howitzer breaks up into six loads for packing; may be carried in any light truck; may be drawn by hand or by one animal; and has a range of 9200 yards with the normal 15-pound projectile. It is hoped soon to have sufficient units to complete practical service test. The present issue 2.95-inch mountain gun is obsolescent.

b. The 105-mm. howitzer (the division howitzer) has been developed in two types, split trail and box trail, and units to equip two regiments have been included in the ten-year program. This howitzer has a maximum range of about 12,000 yards with a 33-pound projectile. The split-trail type has about 45 degrees traverse and the box-trail type about 8 or 9 degrees. Tests of this materiel are still in progress, no standard for manufacture having been adopted.

c. A new 75-mm. gun (the division gun) is being developed but the existing types will be employed in any probable war of the future since both materiel and ammunition exist in quantity. Development includes both the split-trail and box-trail types of carriages with maximum traverses of 45 degrees and 9 degrees, respectively. Types now under test have a maximum range of about 14,800 yards with the 15-pound projectile. Some field artillerymen feel that too much increased weight has been paid for this increased range.

d. The new model 4.7" gun is designed to replace the 155-mm. G. P. F. as the corps gun. So far as tests have gone this type has been most favorably considered. It has a split-trail carriage; a traverse of 60 degrees, and a maximum range of about 20,000 yards with a 50-pound projectile. It is transported in a single load weighing about 12,700 pounds. Due, however, to probable difficulty of procurement of the high grade steel of which the pilot was made, a new model is under design.

e. The present 155-mm. howitzer is an excellent weapon which exists in quantity and it will be the corps howitzer of the next war. It weighs about 8200 pounds in firing position, and experiment is now under way looking to giving it strategic mobility. The 155-mm. howitzer deserves consideration in any study of the army types for a field army. It has a maximum range of 12,400 yards with a 95-pound projectile.

The most recent development in this type is a howitzer having 50 degrees traverse; weighing, in one load, about 15,500 pounds; and having a maximum range of about 16,400 yards. Service tests have not been completed.

f. Development of an improved 155-mm. G. P. F. (as the army gun) is still in progress. The pilot gun is designed to have 60 degrees traverse; a maximum range of about 26,000 yards with a 95-pound projectile; and to be transported in two loads.

g. An 8-inch howitzer (the army howitzer) is being developed to replace the 240-mm. howitzer. The latest model has 60 degrees traverse; a maximum range of 18,700 yards with a 200-pound projectile; and is transported in two loads.

14. Progress in development is limited by available funds and such as are available are devoted to the development of selected types. Thus the progress on other types is continually delayed. It is hoped to perfect and to equip gradually with the new pack howitzer, the 105-mm. howitzer and the 4.7-inch gun. For other types it is hoped to perfect a standard, for manufacture during some future war. We must expect to enter the next war with the materiel now on hand.

# The Mathematics of Antiaircraft Deflections with Particular Reference to the R. A. Corrector

*By Captain GORDON B. WELCH, C.A.C.*

MANY officers of the Coast Artillery Corps serving with antiaircraft artillery have used the R. A. Corrector for the determination of firing data and have obtained excellent results with it. Few of them know, however, the ingenious mathematical struggles which this instrument employs in the computation of antiaircraft deflections, and it is to satisfy their very natural curiosity with regard particularly to the improving factor and the complementary term that this paper has been undertaken.

In current texts on antiaircraft gunnery, many kinds of deflections are discussed. Among them are approximate deflections, secondary deflections, principal deflections, etc. In the general sense of the term, a deflection is the angular difference between the line joining the gun and an aiming point and the line joining the gun and an imaginary point such that if the gun is laid in the vertical plane of this line, it is correctly pointed for direction. To define a deflection more closely, it is necessary to specify the plane or planes in which the angular difference will be measured. Thus, in our antiaircraft service, angular differences are measured in two components called respectively vertical deflection and lateral deflection because they are measured, the one in a vertical plane, the other in the horizontal. The total deflections as finally set up on our guns are the algebraic sums of the principal and secondary deflections. These secondary deflections are really deflection corrections made necessary by wind, drift, and other causes more or less unknown. The principal deflections are those made necessary by the travel of the target during the time of flight and it is the mathematical relations and solutions of the principal lateral and the principal vertical deflections which are to be discussed here.

The mathematical solution of principal deflections for use by antiaircraft artillery has been attacked from many different

viewpoints and in many different ways. Solutions have been based upon approximate deflections derived from tachymetric or rate-measuring instruments such as the Brocq apparatus. Others have been based on a consideration of the target's course and real speed. Some of these solutions have had considerable practical success, others have not fared so well. It is proposed here to give an accurate mathematical solution for the vertical and lateral angles at the gun swept through by a target travelling on a rectilinear course at constant altitude and speed during the time of flight to the position it will have attained at the end of that time of flight, and to show the application of this solution in the data computer known as the R. A. Corrector. The elements of the target's position and motion in space which are assumed to be known and upon which the solution will be based are the vertical

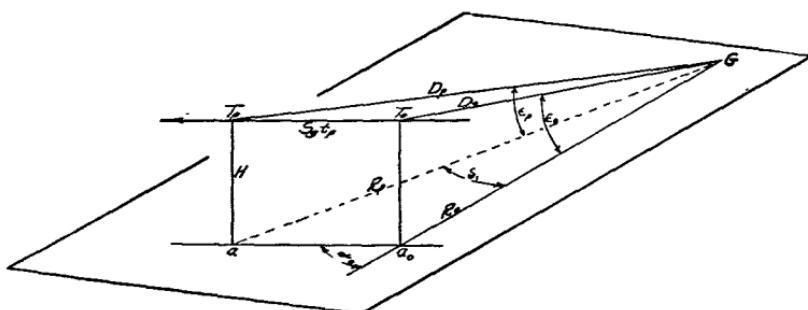


FIG. 1

and lateral angular velocities, altitude, and angular height. The solutions offered are not original with the writer, although considerable time and study was necessary to dig them out of their various hiding places and to place them in suitable form for this discussion.

The set-up in space of the problem to be solved is shown in Figure 1. Here a target is travelling along the line  $T_0T_p$  at an altitude  $H$  above the plane of the gun at a constant speed  $S_g$ . The time of flight of a projectile to the point  $T_p$  is  $t_p$  seconds, and if the gun is fired when the target is at  $T_0$ , the projectile and the target will meet at  $T_p$ . The length of the line  $T_0T_p$  is  $S_g t_p$ . The angle made by this line in its horizontal projection with the horizontal projection of the line of sight at the instant of firing is the angle of path, here called  $\alpha_0$ . The horizontal angle between the plane  $G\alpha_0T_0$  and the plane  $G\alpha_0T_p$  is the principal lateral deflection,  $\delta_1$ . The

angular difference between the angular height  $T_0 G a_0$  and the angular height  $T_p G a$  is the principal vertical deflection,  $\sigma_1$ . At each instant during the target's travel along the line  $T_0 T_p$ , its azimuth and angular height as seen from the gun are continually changing. The rate of change of azimuth is called the lateral angular velocity,  $\Sigma_a$ . The rate of change of angular height is called the vertical angular velocity,  $\Sigma_e$ .

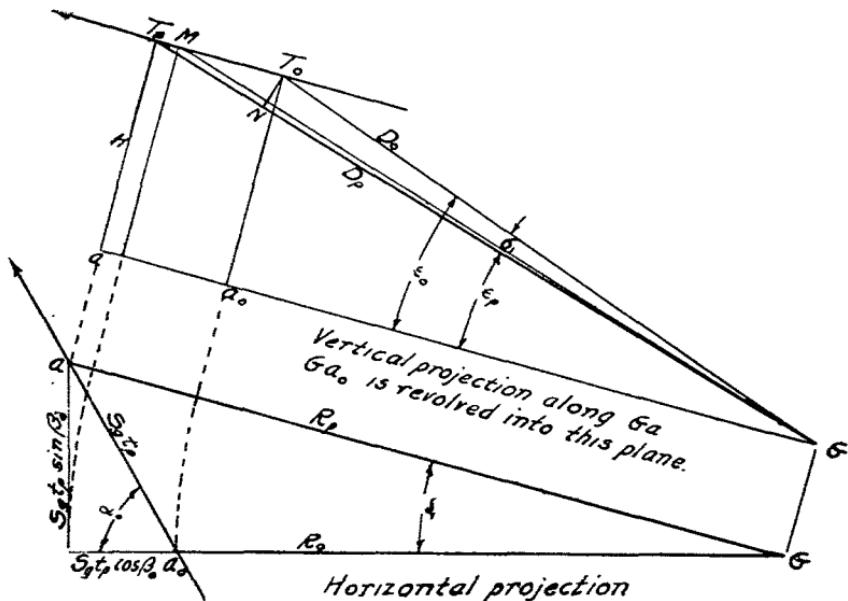


FIG. 2

Note:  $\beta_0$  should read  $\alpha_0$  in Fig. 2.

Hereafter in the solution of the two deflections, these symbols will be used to represent the initial angular velocities, that is, the vertical and lateral angular velocities when the target is at  $T_0$ .

It is now necessary to represent the various angles shown in Figure 1 with a little more accuracy. Figure 2 shows this same set-up in its horizontal and vertical projections. The vertical projection has been taken in the plane  $G T_p \alpha$  and the plane  $G T_0 \alpha_0$  has been revolved into this plane for the purpose of comparing the vertical angles.

Let us first solve for the lateral deflection,  $\delta_1$ .

$$\sin \delta_1 = \frac{S g t_p \sin \alpha_0}{R_p} \quad (1)$$

The lateral angular velocity at  $T_o$ ,  $\Sigma_a$ , is, of course, equal to:  $\frac{S_g \sin \alpha_o}{R_o}$  (2)

Using this value in (1), we have:

$$\sin \delta_1 = \Sigma_{at_p} \frac{R_o}{R_p} \quad (3)$$

This can be transformed in several ways. The most convenient is to throw the term  $R_o/R_p$  into an expression involving angular height. Thus,  $R_o = H \cot \epsilon_o$ , and  $R_p = H \cot \epsilon_p$ . Substituting these values we have:

$$\begin{aligned} \sin \delta_1 &= \Sigma_{at_p} \frac{H \cot \epsilon_o}{H \cot \epsilon_p} \\ &= \Sigma_{at_p} \frac{\sin \epsilon_p}{\sin \epsilon_o} - \frac{\cos \epsilon_o}{\cos \epsilon_p} \end{aligned} \quad (4)$$

The vertical deflection can be solved in a somewhat similar manner.

$$\sin \sigma_1 = \frac{T_o N}{D_o}$$

$$T_o N = (T_o M + M T_p) \sin \epsilon_p$$

$$T_o M = S_g t_p \cos \alpha_o$$

$$\text{Therefore, } \sin \sigma_1 = \frac{S_g t_p \cos \alpha_o \sin \epsilon_p}{D_o} + \frac{M T_p \sin \epsilon_p}{D_o} \quad (5)$$

The vertical angular velocity at  $T_o$  is expressed by:

$$\Sigma_e = \frac{(S_g \cos \alpha_o) \sin \epsilon_o}{D_o}$$

Using this expression in (5), we have:

$$\sin \sigma_1 = \Sigma_{et_p} \frac{\sin \epsilon_p}{\sin \epsilon_o} + \frac{M T_p \sin \epsilon_p}{D_o} \quad (6)$$

It remains now to find a suitable transformation for the expression  $\frac{M T_p \sin \epsilon_p}{D_o}$

$$\begin{aligned} M T_p &= R_p - R_p \cos \delta_1 = R_p (1 - \cos \delta_1) \\ &= R_p \left( \sin \delta_1 \tan \frac{\delta_1}{2} \right) \end{aligned} \quad (7)$$

$$\text{Now, } \frac{H}{D_p} = \sin \epsilon_p \text{ and } \frac{H}{D_o} = \sin \epsilon_o$$

Solving for H and equating we have:

$$D_p \sin \epsilon_p = D_o \sin \epsilon_o$$

$$\text{Whence, } \sin \epsilon_p = \frac{D_o}{D_p} \sin \epsilon_o \quad (8)$$

Substituting (7) and (8) in the second member of (6)

$$\frac{MT_p \sin \epsilon_p}{D_o} = \frac{R_p \sin \delta_1 \tan \frac{\delta_1}{2} \frac{D_o}{D_p} \sin \epsilon_o}{D_o}$$

and since:

$$\frac{R_p}{D_p} = \cos \epsilon_p,$$

$$\frac{MT_p \sin \epsilon_p}{D_o} = \sin \delta_1 \tan \frac{\delta_1}{2} \sin \epsilon_o \cos \epsilon_p$$

$$\text{and } \sin \sigma_1 = \Sigma_{et_p} \frac{\sin \epsilon_p}{\sin \epsilon_o} + \sin \delta_1 \tan \frac{\delta_1}{2} \sin \epsilon_o \cos \epsilon_p$$

Noting now that the angular height in the case considered was decreasing we should change the signs of the expression just derived so that in this case.

$$\sin \sigma_1 = - \Sigma_{et_p} \frac{\sin \epsilon_p}{\sin \epsilon_o} - \sin \delta_1 \tan \frac{\delta_1}{2} \sin \epsilon_o \cos \epsilon_p$$

But if  $\Sigma_e$  be considered as negative, since  $\epsilon$  is decreasing, we can say that:

$$\sin \sigma_1 = \Sigma_{et_p} \frac{\sin \epsilon_p}{\sin \epsilon_o} - \sin \delta_1 \tan \frac{\delta_1}{2} \sin \epsilon_o \cos \epsilon_p, \quad (9)$$

which is the general expression.

We have now derived mathematically accurate expressions for the vertical and lateral deflections and it is to be noted that each is dependent upon the other. They are evidently simultaneous equations neither of which can be solved without the other. The initial elements, H,  $\Sigma_a$ ,  $\Sigma_e$ , and  $\epsilon_o$  can be considered as known but  $t_p$  and  $\epsilon_p$  present practical difficulties. Mechanically, their determination is not difficult. Mathematically, they must be sought by methods of successive approximations.

We will now take these mathematically accurate expressions and see by what transformations and approximations they were adapted for use in the R. A. Corrector. In this instrument we have available at any instant for use in determining the desired deflections, the following known elements of the target's position and motion:

- (a) Instantaneous vertical angular velocity. This is proportional to the rate of turning of the elevating handwheel.
- (b) Instantaneous lateral angular velocity. This is proportional to the rate of turning of the traversing handwheel.
- (c) Instantaneous angular height. This is set up in the instrument by the act of pointing the sights in elevation.
- (d) Altitude. Determined by another instrument and set into the R. A. Corrector.

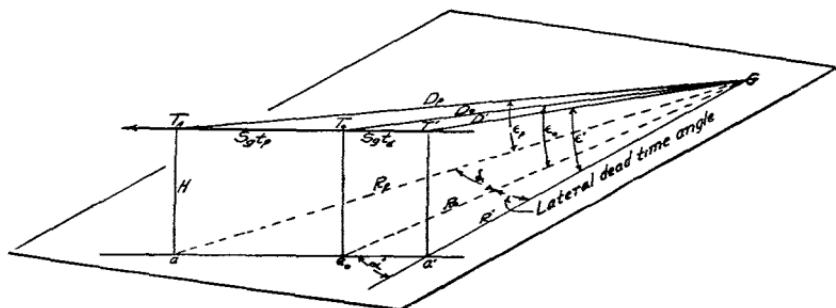


FIG. 3

In computing the deflections, telephoning them to the guns, setting them on the sighting apparatus, and firing the guns, several seconds are used up, so that the instantaneous values of vertical and lateral angular velocity and angular height of the target used by the instrument in computing the deflections are not those functions pertaining to the point  $T_o$  on the target's course but to some other point at which it was a few seconds (known as the dead time,  $t_d$ ) before the gun was fired. This point we can call  $T'$ . Let us call the angular height of the target at this point  $e'$  and the angular velocities respectively  $\Sigma'_a$  and  $\Sigma'_e$ . Figure 3 shows the set-up in space for this problem. The R. A. Corrector, by means of the roller and disc friction drives, can take the instantaneous angular velocities and multiply them by an appropriate time of flight, thus giving an approximate solution of the deflections. It is so constructed, however, that the time of flight used is that to the point  $T'$  instead of to  $T_p$ . Thus the product  $\Sigma' a t'$  would have in it the following errors:

- (a) An error due to the fact that  $t'$  is used instead of  $t_p$ .
- (b) An error due to the fact that an instantaneous angular velocity is used instead of an average value.
- (c) A subsidiary error due to the fact that the instantaneous angular velocity used is that pertaining to the point T' instead of  $T_o$ .

To correct for these errors in the lateral deflection, an improving factor is introduced and called M, so that the principal lateral deflection as finally turned out is as follows:

$$\delta_1 = \Sigma' a t' M.$$

In like manner the same errors are corrected for in the vertical deflection by the use of a complementary term called X, so that the principal vertical deflection as finally turned out is:

$$\sigma_1 = \Sigma' a t' + X.$$

The determination of suitable values for M and X in terms which permit of ready solution will occupy the remainder of this paper.

It can readily be seen from an examination of Figure 3 that the principal lateral deflection is equal to the angle  $a'G a$  minus the angle  $a'G a_o$ . By applying the principles of equation (3),

$$\text{Sin angle } a'G a \text{ is equal to } \Sigma' a (t_p + t_d) \frac{R'}{R_p}$$

$$\text{and Sin angle } a'G a_o \text{ is equal to } \Sigma' a t_d \frac{R'}{R_o}$$

Assuming the angles equal to their sines and subtracting, we have:

$$\begin{aligned} \delta_1 &= \Sigma' a (t_p + t_d) \frac{R'}{R_p} - \Sigma' a t_d \frac{R'}{R_o} \\ &= \Sigma' a t_p \frac{R'}{R_p} + \Sigma' a t_d \frac{R'}{R_p} - \Sigma' a t_d \frac{R'}{R_o} \\ &= \frac{\Sigma' a t_p R'}{R_p R_o} \left[ R_o + \frac{t_d}{t_p} (R_o - R_p) \right] \end{aligned} \quad (10)$$

From this point on in the discussion, many assumptions not mathematically sound will have to be made. The first of these is that:

$$R_o + \frac{t_d}{t_p} (R_o - R_p) = R'$$

A little study will show that while this is not mathematically accurate, the assumption is valid within fairly small limits of error. Then:

$$\delta_1 = \frac{\Sigma' a t_p (R')^2}{R_p R_o}$$

Now we want  $\delta_1$  to equal  $\Sigma' a t' M$ . To arrive at such a result,

$$M \text{ must equal } \frac{t_p}{t'} \frac{(R')^2}{R_p R_o}$$

From which

$$M = \frac{t_p}{t'} \frac{\tan \epsilon_p \tan \epsilon_o}{\tan^2 \epsilon'} \quad (11)$$

$$\text{Assuming: } \frac{t_p}{t'} = \frac{D_p}{D'} \left( \frac{D_p + H}{D' + H} \right)$$

$$\text{and assuming: } D_p = \frac{H}{\sin \left[ \epsilon' + \left( 1 + \frac{t_d}{t'} \right) \sigma_1 \right]}$$

$$\begin{aligned} \frac{t_p}{t'} &= \frac{H^2}{\sin^2 \left[ \epsilon' + \left( 1 + \frac{t_d}{t'} \right) \sigma_1 \right]} + \frac{H^2}{\sin \left[ \epsilon' + \left( 1 + \frac{t_d}{t'} \right) \sigma_1 \right]} \\ &= \frac{H^2 \left( 1 + \sin \left[ \epsilon' + \left( 1 + \frac{t_d}{t'} \right) \sigma_1 \right] \right)}{\sin^2 \left[ \epsilon' + \left( 1 + \frac{t_d}{t'} \right) \sigma_1 \right] \left[ (D')^2 + D'H \right]} \end{aligned}$$

$$\begin{aligned} \text{And since: } D' &= \frac{H}{\sin \epsilon'}, [(D')^2 + D'H] = \frac{H^2}{\sin^2 \epsilon'} + \frac{H^2}{\sin \epsilon'} \\ &= \frac{H^2 (1 + \sin \epsilon')}{\sin^2 \epsilon'} \end{aligned}$$

$$\text{and } \frac{t_p}{t'} = \frac{\sin^2 \epsilon' (1 + \sin [\epsilon' + (1 + \frac{t_d}{t'}) \sigma_1])}{\sin^2 [\epsilon' + (1 + \frac{t_d}{t'}) \sigma_1] (1 + \sin \epsilon')} \quad (12)$$

$$\text{Assuming: } \frac{\tan \epsilon_p \tan \epsilon_o}{\tan^2 \epsilon'} = \frac{\tan [\epsilon' + (1 + \frac{t_d}{t'}) \sigma_1] \tan [\epsilon' + \frac{t_d}{t'} \sigma_1]}{\tan^2 \epsilon'} \quad (13)$$

and assuming:  $\frac{t_d}{t'} = .25$  (14)

we have, by substituting (14) in (12) and (13) and by substituting (12) and (13) in (11):

$$M = \frac{\cos^2 \epsilon'}{\sin^2 (\epsilon' + 1.25 \sigma_1)} \times \frac{1 + \sin (\epsilon' + 1.25 \sigma_1) \tan (\epsilon' + 1.25 \sigma_1) \tan (\epsilon' + .25 \sigma_1)}{(1 + \sin \epsilon')} \quad (15)$$

which is the form given in the standard texts. It will be noted that this expression involves only two unknowns,  $\epsilon'$  and  $\sigma_1$ . These are provided in the R. A. Corrector,  $\epsilon'$  by pointing the sights,  $\sigma_1$  by reading the vertical speedometer. The solution for M is then found on the corrected time cylinder.

The assumption, (14), that  $\frac{t_d}{t'} = .25$  is equivalent to assuming that the dead time is about 3 seconds and that the time of flight to the point T' is 12 seconds. Whether or not such an assumption is justified is open to question. It probably introduces a small error whenever  $t'$  is any value other than 12 seconds or whenever the dead time is other than 3 seconds.

We will now proceed to derive an expression for X, known as the complementary term. It is set as a negative correction on the vertical deflection speedometer.

Referring again to Figure 3, the principal vertical deflection is equal to the angular difference between  $T'Ga'$  and  $T_pGa$  minus the angular difference between  $T'Ga'$  and  $T_oGa_o$ . Using equation (9), assuming that the angles are equal to their sines, and subtracting, we have:

$$\sigma_1 = \left[ \Sigma' e (t_d + t_p) \frac{\sin \epsilon_p}{\sin \epsilon'} - \sin a'Ga \tan \frac{a'Ga}{2} \sin \epsilon' \cos \epsilon_p \right] \\ \text{minus} \left[ \Sigma' e (t_d) \frac{\sin \epsilon_o}{\sin \epsilon'} - \sin a'Ga_o \tan \frac{a'Ga_o}{2} \sin \epsilon' \cos \epsilon_o \right] \quad (16)$$

Assuming:  $D_o - \frac{t_d}{t_p} (D_p - D_o) = D'$

Assuming:  $a'Ga_o = \frac{t_d}{t_p} \delta_1$

Assuming: Sines and tangents of small angles are equal to the angles themselves.

Assuming:  $\sin \epsilon' \cos \epsilon_p = \sin \epsilon' \cos \epsilon_0 = \sin \epsilon' \cos \epsilon'$

Based on the above assumptions, the validity of which is open to question from a strict mathematical standpoint but which certainly do not introduce any very great errors into the final result, we can write (16) as follows:

$$\begin{aligned}\sigma_1 &= \Sigma'_e \left[ (t_d + t_p) \frac{D'}{D_p} - t_d \frac{D'}{D_0} \right] - \sin \epsilon' \cos \epsilon' \\ &\quad \left[ \sin \left( \delta_1 + \frac{t_d}{t_p} \delta_1 \right) \tan \frac{\left( \delta_1 + \frac{t_d}{t_p} \delta_1 \right)}{Z} - \sin \frac{t_d}{t_p} \delta_1 \tan \frac{t_d \delta_1}{t_p \frac{1}{2}} \right] \\ &= \Sigma'_e \left[ \frac{t_d D'D_0 + t_p D'D_0 - t_d D'D_p}{D_0 D_p (t_p D')} \right] t_p D' - \sin \epsilon' \cos \epsilon' (\delta_1)^2 \\ &\quad \left[ \frac{1}{2} + \frac{1}{2} \frac{t_d}{t_p} + \frac{1}{2} \frac{t_d}{t_p} + \frac{1}{2} \left( \frac{t_d}{t_p} \right)^2 - \frac{1}{2} \left( \frac{t_d}{t_p} \right)^2 \right] \\ &= \Sigma'_e \left[ \frac{(D')^2 t_p}{D_0 D_p} \right] - \frac{1}{2} \left[ 1 + \frac{2t_d}{t_p} \right] \delta_1^2 \sin \epsilon' \cos \epsilon'\end{aligned}\quad (17)$$

Let the second part of the right member of this equation equal  $u$ .

$$\text{That is: } u = -\frac{1}{2} \left[ 1 + \frac{2t_d}{t_p} \right] \delta_1^2 \sin \epsilon' \cos \epsilon' \quad (18)$$

Then by adding and subtracting  $\Sigma'_e t'$  we can write:

$$\sigma_1 = \Sigma'_e t' + \Sigma'_e \left[ \frac{(D')^2 t_p}{D_0 D_p} \right] - \Sigma'_e t' + u$$

$$\text{Let: } X = \Sigma'_e \left[ \frac{(D')^2 t_p}{D_0 D_p} \right] - \Sigma'_e t' + u \quad (19)$$

Then  $\sigma_1 = \Sigma'_e t' + X$ , which is in the form we started out to derive. It remains to transform the expression for  $X$  into a form which can be conveniently used on the complementary term cylinder of the R. A. Corrector. Starting with the equation (19),  $X = \left( \Sigma'_e \left[ \frac{(D')^2 t_p}{D_0 D_p} \right] - \Sigma'_e t' \right) + u$ , and multiplying and dividing the first part of the right member by  $\Sigma'_e t'$ :

$$X = \Sigma'_e t' \left( \frac{\Sigma'_e \left[ \frac{(D')^2 t_p}{D_0 D_p} \right]}{\Sigma'_e t'} - 1 \right) + u$$

$$\text{Let } Q = \frac{\Sigma' e (D')^2 t_p}{\frac{D_o D_p}{\Sigma' e t'}} = \frac{t_p}{t'} \frac{(D')^2}{D_o D_p} \quad (20)$$

$$\text{Then: } X = \Sigma' e t' (Q - 1) + u \quad (21)$$

Assuming  $\frac{t_p}{t'} = \frac{D_p (D_p + H)}{D' (D' + H)}$  and substituting in (20),

$$Q = \frac{D_p (D_p + H)}{D' (D' + H)} \frac{(D')^2}{(D_o D_p)} = \frac{D' (D_p + H)}{D_o (D' + H)} \frac{\sin \epsilon_o (1 + \sin \epsilon_p)}{\sin \epsilon_p (1 + \sin \epsilon)}$$

This result is arrived at by means of the trigonometrical relations of the form,  $D = \frac{H}{\sin \epsilon}$

$$\text{Now } \epsilon_o = \epsilon' + \frac{t_d}{t_p} \sigma_1 \quad (\text{approximately})$$

$$\text{and } \epsilon_p = \epsilon' + \left(1 + \frac{t_d}{t_p}\right) \sigma_1 \quad (\text{approximately})$$

$$\text{Therefore, } Q = \frac{\sin \left(\epsilon' + \frac{t_d}{t_p} \sigma_1\right) \left[1 + \sin \left\{\epsilon' + \left(1 + \frac{t_d}{t_p}\right) \sigma_1\right\}\right]}{\sin \left[\epsilon' + \left(1 + \frac{t_d}{t_p}\right) \sigma_1\right] (1 + \sin \epsilon')} \times$$

Expanding by using the law of the sine of the sum of two angles:

$$Q = \frac{\left(\sin \epsilon' \cos \frac{t_d}{t_p} \sigma_1 + \cos \epsilon' \sin \frac{t_d}{t_p} \sigma_1\right)}{\left[\sin \epsilon' \cos \left(1 + \frac{t_d}{t_p}\right) \sigma_1 + \cos \epsilon' \sin \left(1 + \frac{t_d}{t_p}\right) \sigma_1\right]} \times \\ \frac{\left[1 + \sin \epsilon' \cos \left(1 + \frac{t_d}{t_p}\right) \sigma_1 + \cos \epsilon' \sin \left(1 + \frac{t_d}{t_p}\right) \sigma_1\right]}{(1 + \sin \epsilon')} \quad (22)$$

Assume the cosines of small angles equal to unity and the sines of small angles equal to the angles themselves. That is:

$$\cos \left(1 + \frac{t_d}{t_p}\right) \sigma_1 = 1$$

$$\cos \left( \frac{t_d}{t_p} \right) \sigma_1 = 1$$

$$\sin \left( 1 + \frac{t_d}{t_p} \right) \sigma_1 = \left( 1 + \frac{t_d}{t_p} \right) \sigma_1$$

$$\sin \left( \frac{t_d}{t_p} \right) \sigma_1 = \left( \frac{t_d}{t_p} \right) \sigma_1$$

Substitute these assumed values in (22):

$$Q = \frac{\left( \sin \epsilon' + \frac{t_d}{t_p} \sigma_1 \cos \epsilon' \right) \left[ 1 + \sin \epsilon' + \left( 1 + \frac{t_d}{t_p} \right) \sigma_1 \cos \epsilon' \right]}{\left[ \sin \epsilon' + \left( 1 + \frac{t_d}{t_p} \right) \sigma_1 \cos \epsilon' \right] \left( 1 + \sin \epsilon' \right)} \quad (23)$$

Arranging this expression as follows, performing the divisions indicated, and neglecting all terms in  $\sigma_1^2$  as being too small to influence the final result, we arrive at the result indicated in (24).

$$Q = \frac{\left( \sin \epsilon' + \frac{t_d}{t_p} \sigma_1 \cos \epsilon' \right)}{\left[ \sin \epsilon' + \left( 1 + \frac{t_d}{t_p} \right) \sigma_1 \cos \epsilon' \right]} \left[ \frac{1 + \sin \epsilon'}{1 + \sin \epsilon'} + \frac{\left( 1 + \frac{t_d}{t_p} \right) \sigma_1 \cos \epsilon'}{1 + \sin \epsilon'} \right]$$

$$Q = (1 - \sigma_1 \cot \epsilon') \left[ 1 + \left( 1 + \frac{t_d}{t_p} \right) \sigma_1 \frac{\cos \epsilon'}{1 + \sin \epsilon'} \right] \quad (24)$$

By multiplying this expression out and again neglecting terms in  $\sigma_1^2$  we can write:

$$Q = 1 + \sigma_1 \left[ \left( 1 + \frac{t_d}{t_p} \right) \frac{\cos \epsilon'}{1 + \sin \epsilon'} - \cot \epsilon' \right] \quad (25)$$

Now let us follow another trail for a while:

$$\text{Approximately: } \sigma_1^2 = \frac{S_g^2 t_p^2}{D_p^2} \sin^2 \epsilon' \cos^2 \alpha_0 \text{ (from Figure 2)} \quad (26)$$

$$\text{and approximately: } \delta_1^2 = \frac{S_g^2 t_p^2}{D_p^2 \cos^2 \epsilon'} \sin^2 \alpha_0 \quad (27)$$

Multiplying (27) by  $\sin^2 \epsilon' \cos^2 \epsilon'$

$$\delta_1^2 \sin^2 \epsilon' \cos^2 \epsilon' = \frac{S_g^2 t_p^2}{D_p^2 \cos^2 \epsilon'} \sin^2 \alpha_0 \sin^2 \epsilon' \cos^2 \epsilon' \quad (28)$$

Adding (26) and (28):

$$\begin{aligned}\sigma_1^2 + \delta_1^2 \sin^2 \epsilon' \cos^2 \epsilon' &= \\ \frac{S_g^2 t_p^2}{D_p^2} \left[ \sin^2 \epsilon^1 \cos^2 \alpha_0 + \frac{\sin^2 \alpha_0 \sin^2 \epsilon' \cos^2 \epsilon'}{\cos^2 \epsilon'} \right] \\ &= \frac{S_g^2 t_p^2}{D_p^2} \sin^2 \epsilon' [\cos^2 \alpha_0 + \sin^2 \alpha_0] \\ \text{and } \sigma_1^2 &= \frac{S_g^2 t_p^2 \sin^2 \epsilon'}{D_p^2} - \delta_1^2 \sin^2 \epsilon' \cos^2 \epsilon'\end{aligned}\quad (29)$$

since:  $\cos^2 \alpha_0 + \sin^2 \alpha_0 = 1$

It is now desired to combine (29), (25), and (18), substitute in (21), and arrive at a usable value of X. Before doing so, however, another assumption must be made which may be even less valid than those already made. Going back to equation (21) we see that:

$$X = \Sigma' \epsilon t' (Q - 1) + u$$

We must now assume that  $\Sigma' \epsilon t' = \sigma_1$ . This is one of the very errors that we set out to correct. When we notice, however, that  $\sigma_1$  will appear in its squared form and merely as a multiplier in the final solution of X, it can be accepted as a fairly close representation of the true value.

$$\text{Then: } X = \sigma_1 (Q - 1) + u$$

Substituting (25) and (18) in the above, we have:

$$\begin{aligned}X &= \sigma_1^2 \left[ \left(1 + \frac{t_d}{t_p}\right) \frac{\cos \epsilon'}{1 + \sin \epsilon'} - \cot \epsilon' \right] \\ &\quad - \frac{1}{2} \left[ 1 + \frac{2t_d}{t_p} \right] \delta_1^2 \sin \epsilon' \cos \epsilon'\end{aligned}\quad (30)$$

Substituting (29) in (30):

$$\begin{aligned}X &= \left[ \frac{S_g^2 t_p^2 \sin^2 \epsilon'}{D_p^2} - \delta_1^2 \sin^2 \epsilon' \cos^2 \epsilon' \right] \\ &\quad \left[ \left(1 + \frac{t_d}{t_p}\right) \frac{\cos \epsilon'}{1 + \sin \epsilon'} - \cot \epsilon' \right] - \frac{\delta_1^2}{2} \left(1 + \frac{2t_d}{t_p}\right) \sin \epsilon' \cos \epsilon' \\ X &= \sin^2 \epsilon' \left[ \frac{S_g^2 t_p^2}{D_p^2} - \delta_1^2 \cos^2 \epsilon' \right] \\ &\quad \left[ \frac{\cos \epsilon'}{1 + \sin \epsilon'} + \left(\frac{t_d}{t_p}\right) \frac{\cos \epsilon'}{1 + \sin \epsilon'} - \frac{\cos \epsilon' (1 + \sin \epsilon')}{\sin \epsilon' (1 + \sin \epsilon')} \right] \\ &\quad - \frac{\delta_1^2}{2} \left(1 + \frac{2t_d}{t_p}\right) \sin \epsilon' \cos \epsilon'\end{aligned}$$

$$X = \sin^2 \epsilon' \left[ \frac{S_g^2 t_p^2}{D_p^2} - \delta_1^2 \cos^2 \epsilon' \left( \frac{\frac{t_d}{t_p} \sin \epsilon' - 1}{\tan \epsilon' (1 + \sin \epsilon')} \right) - \frac{\delta_1^2}{2} \left( 1 + \frac{2t_d}{t_p} \right) \sin \epsilon' \cos \epsilon' \right]$$

Assuming:  $\frac{S_g^2 t_p^2}{D_p^2} = \frac{1}{36}$  (31), that is, that the distance traveled by a target during the time of flight is always one-sixth of the slant range;

and assuming:  $\frac{t_d}{t_p} = .25$  (32) [Compare (14)]

$$X = \sin^2 \epsilon' \left[ \frac{.25 \sin \epsilon' - 1}{\tan \epsilon' (1 + \sin \epsilon')} \right] \left[ \frac{1}{36} - \delta_1^2 \cos^2 \epsilon' \right] - .75 \delta_1^2 \sin \epsilon' \cos \epsilon'$$

$$\text{Rearranging: } X = \frac{\sin \epsilon' \cos \epsilon'}{1 + \sin \epsilon'} \left[ \frac{1}{144} \sin \epsilon' - \frac{1}{36} + \delta_1^2 \left( .25 \sin^3 \epsilon' - \sin^2 \epsilon' - \sin \epsilon' + .25 \right) \right] \quad (33)$$

This is the form usually given in textbooks for the value of  $X$ , and it is to be noted that it contains only two variables,  $\epsilon'$  and  $\delta_1$ . These are obtained, the one by pointing the telescopes of the R. A. Corrector in elevation, the other by reading the lateral deflection speedometer. The latter reading is set off by rotating the complementary term cylinder. Opposite the moving pointer is then found the value of  $X$  which is to be set off as a negative correction on the vertical deflection speedometer. Now nothing in the derivation of this expression indicates that it is to be used as a negative correction. In fact, the algebraic symbols used all seem to indicate that it should be plus. When, however, these symbols are evaluated it is found that throughout the entire practical range of angular height and lateral deflection, the numerical value of the expression is negative. Adding these values, therefore, is obviously to apply them as negative corrections.

The R. A. Corrector has been a valuable instrument to the antiaircraft artillery since its conception and development and we are greatly indebted to the man or men whose active minds made possible the mathematical circumambulations necessary for the solutions applied on its cylinders and charts.

It is time now, however, to solve our problem more accurately. The accurate mathematical formulae are available and their mechanical solution is not difficult. The speedometers of the R. A. Corrector with their sticking needles and jerky motion must give way to something more sure and steady in its operation. The leather-faced discs are getting old. It should not be necessary to read one chart or scale and set the values so read on another. The operations must be more automatic. Provision must be made for arbitrary corrections of all sorts. Provision must be made for application to Case III firing. Provision should be made for the application of all pertinent ballistic corrections. All these things and more are surely on the way and the study of antiaircraft artillery should prove extremely interesting to those who will watch its development along these lines and lend a hand whenever its progress is slowed up or obstructed.

Note 1.—In this paper is used the new list of symbols approved for antiaircraft gunnery, fire control, and position finding by 9th Indorsement, War Dept., OCCA, dated April 20, 1927.

Note 2.—It would be interesting and instructive to compute the errors introduced by the great number of assumptions made in deriving expressions for the improving factor and the complementary term. Some of these assumptions no doubt were more accurate for the French materiel for which the instrument was originally designed than for our present American materiel. The labor involved in computing the errors was too great, however, and the available time too short for the writer to undertake the necessary computations.

# Set Thy House in Order!

By CAPTAIN WM. A. ROUNDS, J. A. G. D.

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**O**N October 1, 1927, the Army Relief Society had on its relief list 110 families. Well, what of it? Just this. Fifty-one of those families, not individuals, mark you, but families, are the dependents left by deceased Army officers.

Let that go for the moment and consider a recent remark by an Army woman about the future of Mrs. John Doe, widow of the late Captain Doe, Infantry, who was killed suddenly by a fall in a polo game. "Mrs. Doe," she said, "is well provided for. She has only two children, both boys, one seven and the other nine, and John has left her \$13,000 in insurance." The significance of that remark depends on how good you are at mental arithmetic. Before I add this all up and disclose the total, let me put down one more illustration.

Lieutenant Harry Bright, stationed at Fort Niagara, N. Y., having been detailed as instructor in military science and tactics at the Kenesaw Military Academy, near Milestone, Ariz., took a month's leave; he proceeded to Bellingham, Wash., where he quietly married Mary Gordon, his boyhood sweetheart. Accompanied by his bride he reported at his new station. One month later he was killed in his machine at a grade crossing. There was no other Army officer at the Milestone and no Army post within three days' journey. Mrs. Bright, who was a quiet, well educated, capable girl, but wholly unfamiliar with Army regulations and customs and her own rights and privileges as an officer's widow, looked in vain among her husband's effects for a will, insurance policies or anything in writing that might aid and direct her. Very fortunately she had \$800 in cash of her own money. With this she paid off current bills and had her husband's body transported to his home in Minnesota. Shortly after the funeral she went back to Bellingham, where she succeeded in getting back her old teaching position.

Now, then, let us look at the answers. The Army Relief Society is a charitable organization. Certainly if a little foresight, coupled with a slight self-denial, will enable an officer to carry enough life insurance to preclude the need for his family to accept charity, there is something lacking in his common sense and good judgment, not to mention his regard for his family, if he doesn't do at least that much. The time to think, talk and act about this situation is while the girl you married is an Army wife; it is too late when she becomes an Army widow.

It is pathetic how many people do actually consider a widow with two small children "well off," financially independent, even wealthy, if she has \$13,000 in cash all at one time. Let's put it this way. Suppose the late Captain Doe said to his wife, "Now, Alice, you and the children go back to New York and enjoy life. Every month I will send you \$54.17. Get yourself a nice apartment, dress yourself and the children well, don't worry about the grocery, heat, light and telephone bills. My monthly check will cover everything but unnecessary luxuries." Just suppose he said such a thing. What would happen? Yet, as his widow with \$13,000 coming to her, invested safely at the high average rate of interest of 5 per cent, she would get exactly \$650 per year, or \$54.17 per month, \$13.54 a week.

With Captain Doe living, Mrs. Doe puts many a wrinkle in her fair brow trying to budget her expenses on \$336 a month; as his widow, with about one-sixth of that amount to go on, what would she do? Of course, she could spend the principal. Statistics that are quite reliable show that most widows do that very thing, and that the average small estate of between \$12,000 and \$20,000 is dissipated entirely after about seven years. Suppose Mrs. Doe judiciously spends her \$13,000 at the rate of \$2,000 per year. At the end of six years and a half it is gone. The boys are 13 and 15 years old, she herself is approaching middle age, untrained or out of the business world for years, and with little or no prospect of earning a living for herself and the family. What then?

The story about Lieutenant Bright illustrates the widespread lack of knowledge of the rights and privileges of Army widows from the Government, and of the correct procedure in exercising those rights and in readjusting their personal affairs.

The percentage of Army officers who have made a will is higher, I believe, than in any corresponding group of professional men in civil life. I also believe that the percentage of officers who have insured their lives for \$10,000 or more, usually a Government policy, is high. But I know of only one Army officer who has taken the time and trouble to sit down and prepare a complete and accurate set of instructions, letters, telegrams and necessary application forms covering the rights and privileges due his wife after his death. All that his widow will have to do is to fill out the partially completed forms, letters and telegrams that he has prepared. This officer has order and system in his personal affairs; he has faced the possibility of his own death and made an orderly preparation for it; he has "set his house in order."

Let us assume, then, that Captain Roe, while he is in good health and able to exercise foresight and good judgment, has made a will, properly witnessed, leaving to his wife, Mary Roe, his small and simple

estate, and naming her as executrix without bond; that he has also a \$10,000 straight life insurance policy with the Veteran's Bureau (commonly known as War Risk Insurance); \$6,000 worth of insurance with the Army Mutual Aid Association, in two policies of \$3,000 each; a \$5,000 straight life policy, with an old line commercial insurance company, and that he has an automobile and the usual household goods.

The first thing that Captain Doe does is to assemble these papers, and all allied documents, in a safe, fireproof place known to both wife and husband. He puts them into a large manila envelope. On the outside of that envelope he pastes a sheet of white paper on which is type-written the following: "Last will and papers needed in case of my death." Under that title he lists the following items: (This list, not as a cast-iron "sample form" in any sense of the word, is merely a suggested one.)

1. Last Will—Address of attesting witnesses and directions for probate.
2. Partially prepared telegram notifying Adjutant General of death (to be sent only if death occurs outside of Army post or hospital).
3. Original marriage certificate and copies, certified by clerk of the court.
4. Original birth certificates of children.
5. Burial plot assigned in National or owned in a civilian cemetery. Consult local quartermaster.
6. Directions for burial—(a) if death occurs in Army post or hospital. (b) if death occurs off an Army post.
7. U. S. Pension—partially prepared letter to Pension Bureau and application form, copies of marriage and birth certificates of children attached.
8. Six Months' Gratuity Pay—partially prepared letter of application to the Finance Officer, U. S. Army, Washington, D. C. Consult local finance officer.
9. Arrears in Pay—(pay due)—partially prepared Form 297I, Treasury Department, and letter of transmittal to Claims Division, General Accounting Office, Washington, D. C.
10. Compensation—partially prepared letter to U. S. Veterans' Bureau and form of application.
11. U. S. Government Insurance, (policy number), \$10,000, straight life, original marriage certificate, original birth certificates of children, and copy of will attached—partially prepared application form in duplicate and letter of transmittal to U. S. Veterans' Bureau, Washington, D. C.
12. Army Mutual Aid Association insurance policy, straight life, two policies for \$3,000 each, photostat or certified copies of marriage and children's birth certificates attached, partially prepared telegram requesting immediate payment of one-half of face value of policies.

13. Adjusted Service Certificate (World War bonus), value \$1,250, certificate of death attached—partially prepared letter of transmittal to U. S. Veterans' Bureau.

14. Commercial Insurance Policies (face value), (name of company), (policy number), (form of policy), (name of beneficiary), (premium and how paid)—consult local agent of company in preparing application.

15. Money in Bank—joint account at (name and address of bank)—draw checks as usual.

16. Certificates of Death—obtain five copies from Army or civilian doctor and attach as directed.

17. Household Goods—inventory, copy of A. R. 30-960, par. 17, b—consult local quartermaster.

18. Transportation to Home—copy of A. R. 30-920, par. 17—consult local quartermaster.

19. Deed to House at (address) with tax and water rent receipts, insurance policies, and all other papers.

20. Personal Property, title papers to automobile, record of securities in safe deposit vault of (name and address of bank).

21. Income Tax, copy of last return rendered.

With this much done Captain Roe has taken the first important step toward coordinating his affairs. Now, then, let us suppose that he is suddenly stricken ill and dies in a few days at his station. Just what does Mrs. Doe do?

#### BURIAL ARRANGEMENTS

The first thing that requires attention is to arrange for burial. The deaths of officers on active duty usually occur at or near their stations or in Army hospitals. Under these circumstances the funeral arrangements cause little difficulty. The local quartermaster will take entire charge and arrange for local interment or the shipment of the body to the point of burial. This is all done at Government expense.

The remains of a deceased officer on the active list may, subject to local health laws and sanitary regulations, be buried at one of three places—the place of his death, his home, or in a National cemetery. Officers should leave instructions on this point. It is no longer possible for an officer to select a burial lot in a National cemetery during the officer's lifetime; so, if he leaves instructions for burial in the Arlington National Cemetery, Virginia, for example, the widow should immediately telegraph the Quartermaster General of the Army an application for a burial lot in Arlington. The lot is assigned when the remains arrive in Washington and the widow is officially notified by mail.

As soon as the burial arrangements are decided, the widow should send a telegram to the Quartermaster Supply Officer, Washington

General Intermediate Depot, Washington, D. C., giving the date and place of death, dimensions of shipping case, the number in the funeral party, the date, hour and number of the train on which body will reach Washington, and whether she wants immediate interment or desires the body placed in the receiving vault at the cemetery pending burial arrangements to be made later. The remains will be met at the railroad station and conveyed to Arlington. The services of an undertaker in Washington are not required, nor is there any expense attached to opening and closing the grave. Parenthetically, I may add that the Government, where a private monument is not provided, will erect a white marker headstone of regulation pattern inscribed with the deceased's name, rank and service. If the widow contemplates erecting a monument in a National cemetery at her own expense, she should not place the order until both the design and the inscription have been submitted to and approved by the Quartermaster General. As I said above, the Government bears the expenses of the undertaker's services, the cost of the casket and the shipping box, and the hire of the hearse. It also furnishes authorized necessary transportation, and, when needed, clothing. Of course there is necessarily a fixed limitation to the burial expenses that the Government will bear. If the widow wishes to exceed this limitation she must provide for meeting the increased cost from her own funds.

If an officer meets his death off an Army post or outside an Army hospital and under what might be termed exceptional circumstances, such as by drowning, while traveling on a train, by aviation accident, while on leave, or in an isolated station, the common sense thing to do at once is to radio or telegraph his commanding officer and request instructions. Also, no matter who else is notified, a telegram should go immediately to the Adjutant General of the Army, Washington, D. C., setting out the full name of the deceased, his rank, branch of service, date, place and cause of death, and place where he is to be buried, and request instructions as to burial arrangements. This is very important. I did not mention this telegram in speaking of death in an Army post or hospital, because there the commanding officer or his adjutant must send the same information officially, but in any of the above emergencies the person on the spot must do it. If the place of death is remote from an Army post or hospital, and it is impossible to get instructions from Army authorities, the widow may employ a local undertaker and, if necessary, make arrangements for shipment of the body to the place of burial. In such cases the burial expenses proper may not exceed \$100 without the authorization of the Quartermaster General, who may, when the circumstances justify, approve an expenditure of not to exceed

\$150. If the expenses run over \$150 the authority of the Secretary of War must be obtained to secure reimbursement. If the widow has had to bear the expense of the shipment and burial of her husband's body out of her personal funds, and "where such expenses would have been a lawful claim against the Government," she may be reimbursed to the extent of the amount allowed by the Government for such services, by submitting the proof of her expenditures, such as itemized bills or vouchers, to the Quartermaster General of the Army, Washington, D. C.

### THE WILL

I have assumed that Capt. Roe has left a will\* and that Mrs. Roe has it in her possession immediately after his death. What shall she do with it?

The person whom a testator names in his will to carry out its provisions is the executor (or, if a woman, the executrix) and must probate the will. As executrix, Mrs. Roe should produce proof before the Probate Court of Captain Roe's legal domicile that the instrument that she offers to be registered is the last will of her husband. The legal domicile or residence of most Army officers in active service is the residence they had when commissioned. If any doubt arises as to her husband's legal residence, Mrs. Roe should get the advice of counsel on this highly legal and technical question.

Unless the estate—that is, the property left by the testator—is small and involved in no unusual obligations, it is perhaps advisable to employ a lawyer or a trust company to probate the will and attend to the various details. The duties of an executrix are not simple nor can they be done in a day or two. The will must be offered for probate, all persons interested must be notified, and proof, through the attesting witnesses, produced that the will was properly executed. That done, letters testamentary are secured from the Probate Court. The next steps are to take possession of all the assets belonging to the estate, and make a detailed inventory of all property of the decedent. In nearly every State the executor must then advertise for debts against the estate, and receive and record such claims for verification. Another important item is the filing of returns and the payment of Federal estate and income taxes, state inheritance taxes and local personal property taxes. When the debts are all paid the executor will pay out the legacies and other specific bequests set forth in the will, dispose of the balance of the estate as the testator directed. The last step is to submit all accounts to the Probate Court. When the court is satisfied that everything that

\*See "The Army Officer's Last Will," by Captain Rounds, in the November number of the *Infantry Journal*.

the executor has done is just and proper, it will direct a judicial settlement.

The whole procedure of settling an estate takes time, money, and, most of all, a great deal of patience. The painful fact remains that the average estate of \$10,000 or less, depreciates by 20 per cent before it gets into the hands of the widows, children and old parents for whose welfare and happiness the decedent scraped it together by hard work and self-denial.

It seems appropriate to emphasize right here that dying is a costly business, in the Army or out of it. The widow and her children must now face a monthly rent bill—there is no longer quarters or commutation; the family must eat, have clothing, and meet the coal bill and the light bill. The Army widow usually has no doctors' bills or funeral expenses, but she will need ready cash for traveling, settling commissary and other bills, and to pay lawyers' fees, the costs of settling the estate, the various tax bills and what not. Carrying an amount of life insurance commensurate with his income will enable an officer to provide for this need and save his wife many troubles at what is bound to be an especially difficult time. That provision is one of the few that an Army officer, wholly dependent on his pay, can make to assist his wife when he cannot be there to help her.

#### JOINT BANK ACCOUNT

A joint bank account for husband and wife, or an adequate account in the name of the wife, alone, is another means for providing some ready cash for immediate needs on the death of the husband. If the family's current funds are deposited in a local bank under the husband's name alone, the widow cannot draw checks against that account after his death, even though he may have willed it to her, until she has probated his will and obtained letters testamentary that authorize her to take over the assets of the estate; or, if he left no will, the money may be drawn out only upon the authority of the administrator that the court appoints to take charge of the estate.

Another source of ready money is the six-months' gratuity pay provided for by law. The widow of every Army officer or soldier on active duty who dies from wounds or disease, not the result of his own misconduct, is entitled to an amount equal to six-months' pay at the rate that the officer was receiving at the date of his death. As used here, the word pay means only base and longevity pay, and does not include allowances. This gratuity is not paid to a married child nor to an unmarried child more than 21 years old and not actually a de-

pendent of the deceased officer. It may be paid the widow of an officer, or to his minor unmarried child, without proof of dependency, but payment to any other designated beneficiary may be made on proof of dependency to some degree. The right to receive this gratuity is purely personal and vests solely in the designated beneficiary. The widow and children of the deceased are prior beneficiaries in the order named; only if an officer leaves neither widow nor child can another person become the beneficiary, and then only if related to the officer by blood or by marriage and, to some extent, dependent upon him. A friend is not eligible for this gratuity. All officers have to name a beneficiary of this gratuity, and this information is filed in the office of the Adjutant General. Because this gratuity is not a debt due an officer and cannot become part of his estate, he cannot designate a beneficiary of it in his will.

Ordinarily an officer's widow does not have to initiate a claim for this gratuity, as the Chief of Finance of the Army, having been officially notified by the Adjutant General of the death of the officer, usually forwards to the widow or other beneficiary previously designated by the officer a gratuity pay voucher prepared for signature. When this is signed and returned, payment of the gratuity is very prompt. If, however, Mrs. Roe should not receive such a voucher, and is so located that it is impossible to get in touch with a finance officer, she should write to the Chief of Finance, U. S. Army, Munitions Building, Washington, D. C., and request him to send a gratuity pay voucher (War Department Form No. 340) prepared for her signature. Her letter should state her husband's full name, rank, the place, date and cause of his death, and her relationship to him. In the ordinary case there is no delay in the payment of this gratuity and, when there has been an emergency and the money was badly needed, it has been cabled to the widow two days after her husband's death.

#### HOUSEHOLD GOODS

What disposition to make of household goods is another thing that will demand attention. Army Regulations 30-960, paragraph 17, b, provide that the effects of officers who die in the service "may be shipped from their last duty stations or place of storage to such places as may be the home of their legal heirs." This means, of course, the place that Mrs. Roe has selected as her new home. The local quartermaster will take care of the packing, crating and shipping as in a change of station.

**TRANSPORTATION FOR THE WIDOW AND CHILDREN**

If Captain Roe died at a station a long distance from his home or from the place Mrs. Roe expects to make her next abode, the estimated expense of transportation for her and the children to that point may amount to a considerable sum. Curiously enough there is no appropriation act or Army regulation that places the obligation of this expense upon the Government, so that she is not entitled to such transportation either as a right or a privilege. Nevertheless, Army regulations do provide (A. R. 30-920, par. 17 c (1) (a)) that an officer's body may be accompanied on its journey to the place of burial by an escort at Government expense, and it is permissible and customary to designate the widow and children as the escort, and as such to provide their transportation in kind.

Before leaving the Army post or hospital where Captain Roe died, Mrs. Roe should be sure to obtain six copies of the certificate of death from the Army doctor in attendance at his last illness. One copy of this certificate must accompany each of the following applications:

1. Government Insurance.
2. Adjusted Service Certificate (World War Bonus).
3. Pension.
4. Death compensation, U. S. Veterans' Bureau.
5. Commercial insurance policies.

Another thing that Mrs. Roe should do is to call upon at least two officers who were friends of Captain Roe to identify his remains before the casket is closed. The formal proof of death required by commercial insurance companies usually requires that affidavits of identification of this kind be filed with the claim for insurance. The U. S. Veterans' Bureau also requires it if an officer dies while not in active service.

Mrs. Roe is also entitled to the pay and allowance due Captain Roe from the day he was last paid to and including the day of his death. This amount is known as the "arrears of pay." In order to obtain this pay due Mrs. Roe must make out a special form, known as "Application of Widow for Arrears of Pay," Form 2971, Treasury Department. Though this form is obtained from the Finance Officer, U. S. Army, Munitions Building, Washington, D. C., Mrs. Roe should not send it there, but to the Claims Division, General Accounting Office, Washington, D. C. The actual payment made under this application may require considerable time, perhaps two months or more, so that the general accounting office may ascertain whether or not there are any debts or obligations owing from the officer to the Government. In making out form 2971, Mrs. Roe must supply the following facts: Her age, record of her husband's service (from Army Register), date and

place of his birth, date and place of his death, her maiden name, place and date of marriage, whether or not she is now pensioned, and her postoffice address. To that much of the form she must take an affidavit before a notary, and have her signature witnessed by two witnesses. She must then have two friends of the family make a further affidavit on the lower half of the same form, declaring that they knew Captain Roe, knew Mrs. Roe to be his widow, that Captain Roe and Mrs. Roe lived together as man and wife and were so recognized by the community where they resided when Captain Roe died, that these declarants have no interest in this application, and their addresses. They must then each sign the affidavit and two witnesses witness their signatures.

#### WORLD WAR BONUS

If Captain Roe was in the service during the World War, but not in the Regular Army, and held no grade higher than captain, Mrs. Roe will probably find among his papers a document somewhat resembling a bond, described on the back as an "Adjusted Service Certificate." This is commonly known as the Federal or World War Bonus. It is in effect an insurance policy. This bonus is not payable to officers of the Regular Army who served in the World War in any grade, but only to enlisted men, lieutenants and captains who served in the World War in other components of the U. S. Army, such as the National Army, the Reserve Corps or the National Guard. Nearly all of the so-called emergency officers who came into the Regular Army in 1920 are entitled to and have applied for and received this bonus certificate. This paper names a sum of money, which represents the adjusted compensation insurance to which Mrs. Roe, as the beneficiary whom Captain Roe designated when he applied for the bonus, is entitled upon his death. The certificate does not give the name of the beneficiary, and the veteran should therefore acquaint the person whom he so designated. In order to obtain the insurance due on this certificate, Mrs. Roe should state in writing in the proper place on the back that she, Mary Roe, is the beneficiary designated by Captain Roe, and should swear to the affidavit before a notary public or a postmaster. Having attached a certificate of death therein, she should mail both papers to the United States Veteran's Bureau, Washington, D. C. The serial number should appear on the certificate so that it may be easily traced upon the records of the Veterans' Bureau. If Captain Roe has obtained a loan from a bank and deposited the adjusted service certificate as collateral, as he would be obliged to do, Mrs. Roe should write to the Veterans' Bureau, stating the facts and giving the name of the bank. The Bureau will then pay

off the loan, with the interest due, to the bank and remit the balance to her. If Mrs. Roe is in doubt as to whether or not she is really the beneficiary, she may send a telegram to the Veteran's Bureau stating that she is the widow of Captain Roe, that she has the certificate in her possession, and asking that Bureau to notify her whom Captain Roe named as the beneficiary.

#### WAR RISK INSURANCE

The largest single asset in the estate of most Army officers who have no outside income is the sum of \$10,000 from their War Risk Insurance, commonly known as term insurance, or, more accurately, from the same thing converted into some form of Government insurance. During his lifetime Captain Roe probably paid the premiums on this insurance by noting an allotment for that purpose each month on his pay voucher. If this was so, it might expedite payment of this claim if Mrs. Roe should obtain and attach to her application a certificate from the local finance officer who last paid her husband, to the effect that Captain Roe deducted this premium on his last pay voucher. Unless Captain Roe has deposited his policy with Veteran's Bureau as collateral on a loan, Mrs. Roe should have it in her possession.\*

Now, then to collect this insurance Mrs. Roe must properly fill out, in duplicate, Form 514 (U. S. Veterans' Bureau, Adjudication Service) and mail it to the United States Veterans' Bureau, Arlington Building, Washington, D. C. She could have saved time by obtaining this form during her husband's lifetime and partially completing it then, and by filing with the Veterans' Bureau at the same time a court copy of her marriage certificate and duly certified birth certificates of the children. Since she did not obtain form 514 in advance, she should write a letter to the Veterans' Bureau asking for it, and at the same time set out carefully Captain Roe's full name and grade, the amount and kind of insurance described in the policy, and the policy number. Mrs. Roe should then supply on the form that the Veterans' Bureau will send her the following information: Date, place, and cause of Captain Roe's death; whether or not he left a will (attaching a copy if he did); the date of her birth; her relationship to the insured; and whether or not either of them had been married before (in which case she must attach a certified copy of the court decree of divorce or annulment, or a certificate of death of the deceased spouse of such former marriage); places where Captain Roe lived for the five years preceding his death; the date of his birth; the fact that he was married at the time of his death; and the place his widow and family then resided; the full names,

\*Have you yours?

relationships, and addresses of all of his surviving relatives. She should then go before a notary and make affidavit to the correctness of these statements. After that she should secure the affidavits of two persons who are well acquainted with her, who, having read the statements of fact that she has made, state that they are true. There is a space for these affidavits on the back of the form. If Captain Roe had not been on active service, Mrs. Roe would also have had to secure another affidavit by "a disinterested person" to the effect that he has known her husband for a given number of years, that Captain Roe died at (place of date) on (date of death) and that the declarant has seen the body and knows it to be the body of the deceased. This last affidavit of identification is not required if your husband died in active service. Mrs. Roe should now mail this completed form, together with the policy itself, to the Veterans' Bureau. If there are no complications, she will receive her money within two or three weeks.

#### THE PENSION

Mrs. Roe has another claim against the Government—a pension. The widow of an Army officer or enlisted man who died by reason of a wound or injury received, or a disease contracted in the service of the United States and in line of duty since March 4, 1861 (and excepting the period of the World War, April 6, 1917, to July 2, 1921,) may be entitled to a pension from the date of his death regardless of how long she had been married to him and whether she is poor or has independent means. The amount of the pension depends on the rank that the husband held at the time of his death. The rate for the various grades is as follows:

Privates and noncommissioned officers .....	\$ 12 per month
Second Lieutenant .....	15 per month
First Lieutenant .....	17 per month
Captain .....	20 per month
Major .....	25 per month
Lt. Colonels and higher .....	30 per month

The pension laws also provide an extra sum of \$2.00 per month for each of the officers' children while they are under 16 years of age. This pension is not payable to the widow and children of officers or soldiers who died by reason of a disability incurred in the World War. Such widows and other dependents receive a "death compensation," which I shall explain farther on.

The first thing that Mrs. Roe must do to get her pension is to ask for it. The pension is not granted automatically. Accordingly, she should

address a letter to the Commissioner of Pensions, Interior Building, Eighteenth and F Streets, N. W., Washington, D. C., stating that she is the widow of the deceased officer, giving his name, rank and place and cause of death. She should outline his service and make particular mention of any war service that he may have had. (Reference to the Official Army Register will give her a correct statement of his commissioned service both in and out of the regular Army.) It is quite important to mention what sort of war service he had, because the pension laws, which are numerous and varied, make different provisions for veterans who had certain amounts of service in the various wars. Having set forth these facts, Mrs. Roe should request the proper form to be used in filing her pension application. In the ordinary case this form is known as "Declaration of a Widow for Original Pension," No. 3-006. The Pension Bureau is governed by Congressional Acts, and accordingly, it has no choice but to require claimants for a pension to establish certain evidence according to the letter of the law before the award of a pension can be made. Mrs. Roe must therefore be prepared not only to exercise considerable patience in her dealings with the Pension Bureau, but to cooperate with it by furnishing the formal data which she will be required to present in order to sustain her claim. She will, of course, be expected to file a court copy of her marriage certificate and duly certified birth certificates of her children. If she was married in a civil community, she can obtain a certified copy of the marriage record from a clerk of the court in the city or county where she was married. If she was married on an Army post or by an Army chaplain, or if her children were born at an Army station or in an Army hospital, she should request a transcript of those records from the Adjutant General of the Army. I strongly advise getting these certificates while both husband and wife are alive. One thing that I want to emphasize is this—that true copies of a marriage certificate, or the birth certificates of children, made by an Army officer or a notary public will not be accepted by the Pension Bureau as evidence in support of a claim. I might also add that this is also true of the Veterans' Bureau.

Where the data required by the Pension Bureau are furnished in due form, there will be just determination of the claim, but if the illness or injuries which resulted in the officer's or soldier's death had absolutely no origin in the service and are not related to or connected with it in any way, then the pension must be denied. The Pension Bureau bases all claims for pensions upon the official sick and service records of the War Department. From this it follows that the officer who goes on sick report whenever he is injured or even slightly ill, thereby guar-

antees to his family any pension rights which may be derived therefrom, because he creates and establishes a written official record concerning his ailments. What might appear to be merely a slight scratch or bruise, or a passing headache, may, in fact, be the beginning of a serious infection or a deep-seated organic trouble, which might lead to death some years later. Statements of an officer's family or friends that they knew him to have been suffering from an injury or disease which resulted in his death are of little or no practical value in establishing the cause of his death before the Pension Bureau. If Mrs. Roe has been previously married, she will be called upon to present proof of the termination of that marriage, and the proper evidence in such a case is a death certificate of the former husband or a copy of the divorce decree certified by the Clerk of the Court in which it was obtained.

The Bureau of Pensions will not undertake to determine, in advance of the filing of a claim and the presentation of the evidence necessary to establish the essential facts, whether a pension can be allowed. Therefore, because the forms of application for a pension are frequently altered, and the requirements of legal proof are changed from time to time due to recent Acts of Congress or Governmental Regulations, it is not always satisfactory to prepare forms for this claim in advance, but this is a matter of discretion. If a widow who is receiving a pension should die and leave a child under 16 years of age, that child would be entitled to the same pension that the widow would have received if she had lived, and also to the additional allowance on account of the child. This pension would continue until there remained no children under 16 years of age.

#### DEATH COMPENSATION

There seems to be considerable uncertainty as to just what "compensation" means, because the term is also used to describe certain payments and rights to which veterans of the World War are entitled during their lifetime under given conditions. The term as used in reference to a deceased veteran is more properly called "death compensation" and is based upon the World War Veterans' Act of June 7, 1924. It is in reality a form of pension payable by the U. S. Veterans' Bureau (Arlington Building, Vermont Avenue and H Street N. W., Washington, D. C.) to the widow, child or dependent parent of a deceased officer or soldier who is shown to have died from a wound, disease, or injury that can be connected with his service in the World War, incurred between April 6, 1917, when the United States entered the war with Germany, and July 2, 1921, when peace was officially declared by a resolution of

Congress. It is immaterial whether or not the injury or disease was incurred "in line of duty," but it must not be "the result of willful misconduct."

Compensation is not to be confused with the "pension," described above. One cannot draw both. Generally speaking, officers now in active service in the Regular Army are not apt to die as a result of their participation in the World War. If Mrs. Roe had not had a right to a pension, she would be entitled to this death compensation. She should then initiate the claim by writing to the Veterans' Bureau and requesting the Adjudication Service Department to forward a blank application (now known as form 527) for "death compensation only." No amount of death compensation will be paid until this formal application is filed with the Veterans' Bureau and the necessary proof submitted of marriage in case of a widow; relationship of parent and child where there are children; and, in the case of parents of the deceased, proof of such relationship, together with proof of their dependency upon the deceased during his lifetime. The monthly compensation in the usual case is as follows:

For a widow only	\$ 30 per month
For a widow with one child	40 per month
For each additional child	6 per month

Having arrived at this point, we see that the many requirements to be fulfilled in preparing the various applications for Government allowances and insurance call for no little skill and attention to detail, and considerable correspondence. It is also, I hope, quite plain that an Army widow's troubles will grow less in proportion to the amount of insurance money that she will receive after her husband's death. If he is insured with the Army Mutual Aid Association, there will be no delay or trouble in collecting. This association, upon receipt of the report of death of your husband in the Adjutant General's office, instantly and automatically telegraphs or cables to the beneficiary one-half of the insurance and mails the other half. It will also without any request from the widow or dependents of members of the association, initiate all steps, prepare all papers and fully advise concerning Government insurance, pension, back pay and other Government allowances.

The Army Mutual Aid Association has built up its strong membership, not only on account of its favorable rates, but also because of its ever-willingness to assist widows of members in adjusting their financial affairs.

As to insurance due on policies of commercial companies, I can only suggest, generally, the following steps to initiate your claim. Telegraph

or cable the home office of the company, the time, place, cause and date of your husband's death; state that you are his widow and the beneficiary designated in the policy; set forth the serial number of the policy, and request necessary forms for application and full instructions. Or you might secure help from the local bona fide agent of the company. The old-established insurance companies do not allow their agents to collect fees for such assistance. Or you may find that your local bank will collect your policy for you at a nominal cost. In any event, do not surrender the policy, which is your only evidence of the company's indebtedness to you, until the company advises you that your claim is perfected, has been allowed and the company is prepared to give you a check for the full amount of the insurance. Some companies will agree to wire to the beneficiary a certain proportion of the face value of the policy in cash immediately upon notification of death of the insured. Look at your policy, read it carefully; for the written provisions that it contains, not verbal promises, determine your rights.

If necessary, an Army widow can always turn to the Army Relief Society for an emergency loan. This organization has three objects: to collect funds and provide emergency relief for dependent widows and orphans of officers and enlisted men of the Regular Army; to aid in securing employment for them; and to solicit and create scholarships and supervise educational opportunities for such orphan children. Depending upon the emergency, this society will advance from \$100 to \$200, and it may even make a monthly allowance of not to exceed \$75 per month for six months. If there is no representative at a post where an officer died, the widow should take up the matter with the post adjutant. If she is not on an Army post she may address the society at 140 West 57th Street, New York City, N. Y.

Finally, I repeat that I can think of nothing wiser for an Army husband and father to do than to assemble now and partially prepare all of these forms, letters and telegrams. The little trouble that it will be to him now will be saved to his widow many times over, and will go far toward insuring to his family the rights and privileges that are theirs. So will he show his devotion and concern for those he holds dear.

Set thy House in order!

# Japanese Landing at Tsing-tao

By LIEUT. COL. CLIFFORD JONES, C. A. C.

BEFORE taking up the details of the actual landing of the Japanese at Tsing-tao it is necessary, in order to give that perspective so desirable in viewing any event, to touch upon the location, topography, and recent history of the scene where this small by-play of the World War was enacted.

Tsing-tao is one of the principal seaports of the Chinese province of Shantung. It is situated at the entrance to the bay of Kiaochow and commands this entrance.

In 1898 Germany, as an indemnity for the murder of two missionaries, was permitted to occupy on a long lease the city of Tsing-tao and two hundred square miles of adjacent territory, together with Kiaochow bay, an anchorage of about 15 by 15 miles. The city of Kiaochow was not included within the territory under lease but was within the German sphere of influence. The German concessions also extended into the heart of Shantung itself, and included the privilege of building certain railroads, one connecting Kiaochow with Tsinan the capital of the province, and itself on the railroad connecting Tientsin on the north with Nanking on the south. The holding and developing of mining property for ten miles on each side of these railroads was included. The territory covered by the mining clause included the rich coal fields near Poshan-hsien and Wei-hsien.

To appreciate the full importance of the advantage thus held by the Germans it is necessary to realize that Shantung is one of the most densely populated provinces of China. Thirty-eight million people live on its fifty-six thousand square miles. The western part forms a part of the Peking plane and is traversed by the grand canal (running from Tientsin to Hangchow) and the Yellow river. The eastern part is mountainous and not so fertile as the plains, but, in addition to coal, has mines of gold, sulphur, iron, and copper. It is in this mountainous portion that Tsing-tao is found, situated on a small peninsular extending to the south, flanked by Kiaochow bay on the west and the Yellow Sea on the east, with a series of high ridges extending practically from coast to coast on the north.

Here, then, was where the Germans had established their outpost in China and here they found themselves isolated at the beginning of the

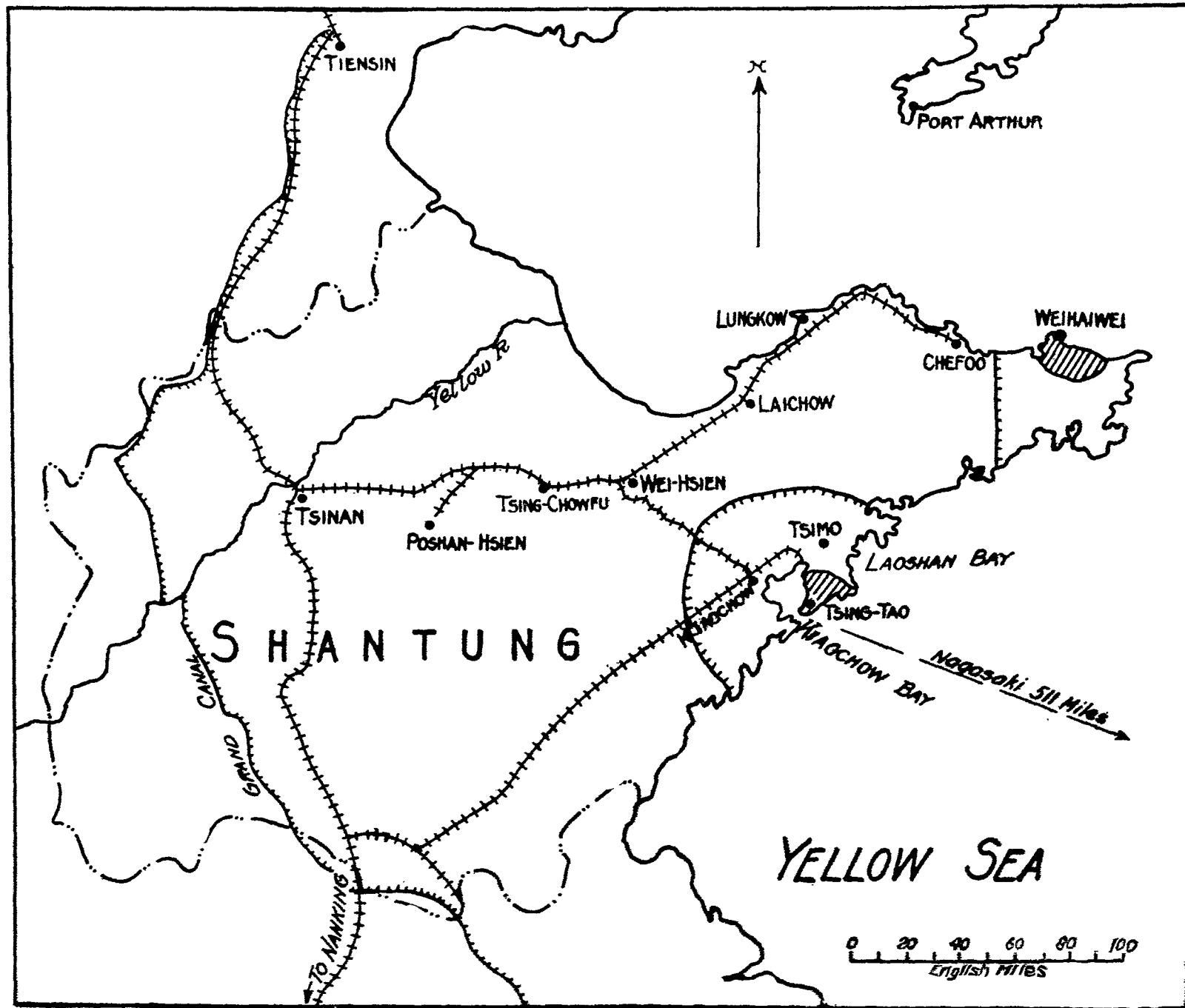
\*One of a series of twenty-minute lectures given by the students of the Coast Artillery School in weekly school conferences.

World War, with Japan only a short distance away and looking covetously on their concessions.

To England, engaged in the desperate struggle of the first months of the World War, Tsing-tao meant not only a commercial base but a naval base as well. With Von Spee's raiders operating against merchant vessels in Far Eastern waters, the Japanese were not long in persuading England that they should be permitted to take a more active part in the war than operations against German and Austrian warships and the protection of British merchantmen in Far Eastern waters. Sir Edward Grey accordingly informed Japan that Great Britain would concur in her plan to drive Germany from Kiaochow, provided she would confine her operations to the China Sea and eventually turn Kiaochow back to China.

The debates in the Chinese Council at that time showed the suspicion with which China looked upon any proposal by Japan eventually to restore Kiaochow to China. The Chinese felt and said that this was only another step taken by Japan towards realizing her desire to dominate China. This suspicion was soon strengthened when the Japanese, in place of landing near Tsing-tao, began debarking at Lung-kow, one hundred and fifty miles north of Tsing-tao, on September 2d and after making first contact with the Germans at Tsimo on September 11th, turned westward along the railroad as far as Tsinan-fu. Shortly thereafter all western Shantung was practically under control of Japan.

Now let us see what preparations were being made by the Germans for the reception of this force which was approaching by such a round-about route though with no uncertainty as to eventual objective. As already mentioned, Tsing-tao is surrounded on three sides by navigable waters, while to the north the terrain is broken by high hills, some of them a thousand feet. On three of these hills, Iltis, Bismarck, and Moltke, were constructed permanent fortifications. Forward of the permanent works at a distance of from one to two thousand yards were five redoubts situated on rising ground with numerous batteries emplaced for their support. These were very strong individually and were really the key to the position, forming together one defensive front consisting of a single glacis extending entirely across the peninsula in advance of two others which curved around the strong points on elevated ground in rear. All three of the glacis were protected by barbed wire on the slopes, and the first two terminated in rear in abrupt drops of fifteen feet into high barbed wire entanglements. There were no dead areas, the entire approach being swept by fire from the redoubts at the crests. Excellent protected communications connected the de-



fensive elements, some of the roads having been cut through as much as thirty feet of rock. The forts were generally equipped with guns of obsolescent type ranging up to about 8.3-inch rifles and about 9.5-inch howitzers and mortars, with some more modern guns of about 6-inch caliber taken from an Austrian cruiser in the harbor. Two other forts commanded the sea approaches and these mounted two guns of about 9.5-inch caliber, three of about 6-inch and two of about 8.3-inch (the latter had been taken from the Chinese in 1900). These forts were supported by three batteries mounting thirteen guns of from about 3 to 6 inches in caliber.

The permanent garrison at Tsing-tao had an authorized strength of about eighteen hundred men but was actually about two hundred short. This was increased by reservists brought in from Far Eastern points to about forty-five hundred. The allied active fighting force consisted of twenty thousand Japanese and a British force of 925 regulars and 300 Sikhs. The Japanese brought with their landing force 142 guns of various kinds, including six howitzers of about 11-inch caliber and eighty other siege guns of from 4.7 to 9.45 inches in caliber. To oppose the sea batteries they had three old battleships, including one British, three old coast defense battleships, and two old cruisers. These mounted in all fifteen 10-inch and 12-inch guns and a number of smaller caliber.

Sunday, August 23, 1914, the day Japan declared war upon Germany, found the Japanese fleet in a semi-circle in the Yellow Sea sailing for the Bay of Kiaochow and a fleet of transports further to the north bearing three divisions. On August 26, the fleet drew up in a semi-circle ten miles out from Tsing-tao, and on September 2 the transports were debarking their twenty thousand men at Lungkow, one hundred and fifty miles north of Tsing-tao.

Admiral Von Spee's fleet had slipped away before the arrival of the blockading fleet, and with his departure the entrance to the bay and adjacent waters had been closed by a mine field of 296 mines (the number reported by an observer with the Japanese was 5000).

The Japanese pushed a force south, and after nine days through a mountainous country where the rivers had been flooded by heavy rains and the roads turned into quagmires, they made first contact with the Germans at Tsimo, about twenty miles north of Tsing-tao. This was evidently only a small detachment of the Japanese and this contact was made as an incident to the general over-running of Shantung.

On September 14 the navy made a reconnaissance of Laoshan Bay about fifteen miles from Tsing-tao, and on September 18 the transports appeared with 15,000 troops from Lungkow. The bay had been mined

but a passage had been swept, and there was no real opposition to landing, though arrangement had been made for the navy to support the debarkation. It appears that the Japanese had no difficulty in sweeping such areas as they desired, since the German guns did not cover the mine fields, and the operations could be carried on without molestation. Laoshan Bay formed an ideal landing place—sheltered on north and west, deep water close in, room on shore for storage and distribution of supplies, and a fair road leading inland to the mountain passes. A floating pier was first used, and later two pile piers were constructed for handling the heavier materiel. Sampans were mostly used for landing men and animals, and iron lighters for guns and similar heavy articles. On September 24 the British force was also landed at Laoshan Bay. All troops, upon landing, moved off into the interior, the first of the Japanese not meeting opposition until about eight miles inland.

Laoshan Harbor was nearer the front than Laoshan Bay and was served by an excellent metal road. It had therefore many advantages as an advanced base for forwarding supplies to the army. By September 27 the area swept was sufficient to warrant an attack on this harbor and on the 28th a landing was made here by a naval force supported by the battleship squadron firing on Fort Iltis and in connection with an advance of the army along its entire front, which now extended across the peninsula. The squadron came under fire of the fort during this engagement but received no hits.

From September 28 until October 31 the lines were gradually pushed forward, the Japanese method of attack being, according to a German writer "stiffly pedantic and in accordance with pre-war pattern of regulations." The defense by their fire during this period made the emplacement of the siege guns in secure positions difficult and the Japanese losses were considerable. The few German and Austrian ships in the harbor joined in this harassing fire until they were outmatched in range by the siege guns and forced to withdraw. The allied fleet bombarbed the seacoast batteries and such of the land batteries as they could reach without themselves coming under effective fire.

By October 30 the Allies had dug themselves in at about 1300 yards from the first barbed wire entanglements and had established a spotting and signal station on a hill 900 feet high and at a distance of 6400 yards from Fort Iltis. From this point both naval and land fire could be directed on any part of the enemy works.

On October 31 a general bombardment by land and sea was begun and the main enemy forts, which up to this time had not been seriously damaged, were practically destroyed by the fire which was continued,

except when interfered with by weather conditions, until November 6. By this time the infantry had advanced their trenches until they occupied a parallel on the crest of the first glacis. During the night of the sixth, three of the five advance redoubts were captured by comparatively small patrols, and by 7:00 A. M., November 7, white flags were flying everywhere.

The Germans, before surrender, had sunk the warships in the harbor, demolished practically every gun and destroyed all military stores possible.

Casualties:

German	600 to 1000
Japanese	1700
British	52
Indian	13

And thus the Rising Sun was hoisted above Tsing-tao. The cross of St. George was conspicuously absent and there was nothing to indicate that the capture had been effected by an allied force—a force in which for the first time in history a white army had fought under a leader of the yellow race. On December 9, 1924, Baron Kato, Foreign Minister, announced in the Diet that Japan had never guaranteed to any nation eventually to restore Kiaochow to China, and the peace treaty provided that all privileges heretofore enjoyed there by Germany should pass to Japan. The worst fears of the Chinese had been realized.

**MAXIM IV**

*When the conquest of a country is undertaken by two or three armies, which have each their separate line of operation, until they arrive at a point fixed upon for their concentration, it should be laid down as a principle, that the union of these different corps should never take place near the enemy: because the enemy, in uniting his forces, may not only prevent this junction, but may beat the armies in detail.—Napoleon's Maxims of War.*

# The Selection and Defense of Naval Bases

By MAJOR HARRY W. STARK, *Coast Artillery Corps*

**A** NAVAL BASE is a navy yard on a fortified harbor containing wharves, docks, storehouses and machine shops for the supply, equipment and repairing of naval vessels. The best naval bases are those at or near the large commercial ports where they are comparatively free from attack and have at hand large accumulations of supplies needed for the service of the fleet.

A very important item in the process of naval development is the establishment of naval bases. A base, in a military sense, is simply a basis of operations or point from which supplies may be drawn. A naval base means that and much more. A mere designation of a certain point as a naval station does not necessarily carry with it the fact that this point is a naval base, in the technical sense of the word. Many stations exist which are termed "bases" that have no real value as base factors in time of necessity.

Along with the rapid development of the large-calibered gun battleship goes, or should go, the corresponding development of all that makes her an efficient instrument of war; her motive power, armament, personnel, munitions, and means of repairing, docking, and refitting. As battleships increase in number and size, so must all the elements that contribute to their efficiency increase, otherwise there is no real naval progress.

From an examination of the great military ports of the world, Admiral Luce was led to conclude that the constituents of a naval base of the first order, are, roughly speaking, about as follows:

1. Its situation must be at the best strategic point within the area under consideration.
2. It must afford a safe harbor for a fleet of at least from twenty-five to thirty battleships with their auxiliaries, aggregating a total of about sixty heavy draft ships and numerous small craft.
3. Such anchorage must be within the lines of defense.
4. It must afford ample docking facilities, at one and the same time, for at least four ships of 45,000 tons displacement, each of thirty-eight feet draft.
5. The interior lines of communication to the sources of supply should be such as may be fully secured in time of war.
6. It should be easy of access and egress and admit at mean low

water, without constant recourse to dredging, ships of the heaviest draft of water, say 38 feet.

7. It should be in proximity to a community able to furnish skilled labor in the departments of steel shipbuilding and marine engineering.

8. The facilities of the neighborhood for furnishing the materials which enter into these industries should be ample.

Due to the comparatively recent introduction in the use of oil as fuel for naval vessels, it would seem that the maintenance of large naval bases overseas is not so much a matter of vital importance as when these vessels were dependent on frequent return voyages to the coaling base. Now a ship can refuel herself at sea from a naval tanker accompanying her in convoy and these frequent return journeys to the base are not necessary.

Confederate cruisers, using a combination of sail and steam power, kept the sea for years without touching at a Confederate port, but such feats would be impossible today on account of more stringent neutrality laws and the increased amount of fuel required for steam vessels. A century and a quarter ago Suffren could deliver three hard fought battles and make all needed repairs in open roadsteads, but no navy today could fight a worthy antagonist and then refit from a floating repair shop. The Russian fleet would not have undertaken its all-starred voyage to the Far East had the Japanese been able to deny Vladivostok to this fleet as effectually as they did Port Arthur. The scenes that attended the scattered Russian vessels seeking refuge in neutral ports after the battle of Tsushima will probably be re-enacted after every hard fought battle in the future unless friendly ports are near at hand. As regards badly disabled vessels this will be true even for the victorious force. As Darrieus, the French naval historian, says, "If at every period of naval history fleets have had pressing need to secure 'advanced bases,' centers for laying up, refitting, etc., where the ships can go to be repaired, to get new supplies, or even merely to rest, above all during the winter, from the fatigues of long cruising, never have these 'bases of operations' been more indispensable than nowadays."

"When the wind was the only moving force, a fleet well provided with food and ammunition could, if need there were, keep the sea for long months, and at a pinch even put into port on a foreign coast. Suffren in his great campaign of the Indies remained away from Reunion, his only friendly port, during twenty-two consecutive months. He, however, would have had no rest from the English if he had not supplied himself with the lacking essential for prolonged cruising, an advanced base which he secured by the capture of Trincomali. In our

time, needs of this kind are infinitely more pressing. Though modern ships of war carry enough food to support their crews for several months, on the other hand, they do not carry the oil or coal more than sufficient to supply them with propulsive power for a few days. The obligation to return to port for coal, or to tie up to her accompanying naval tanker, is imperious. Moreover, steel hulls in sea water become covered with marine growth of various sorts, and under penalty of seeing the high speeds which are a strategic factor of the first importance greatly reduced, periodic visits to a base are necessary. This considers only the daily life of a naval force. What must be added when one thinks of the needs entailed by bad weather, of the repairs of all sorts necessary to restore to fighting trim the ships composing a force just emerging from battle, *even if victorious*. Modern bases of operations, then, require considerable supplies of provisions, ammunition, fuel (either coal or oil or both), lubricants, spare articles, raw materials, dry docks, repair shops well equipped with various tools, all under the safeguard of defenses which can not be too strong, since the question is to guarantee the security of the preparations of naval operations. It was much more from the complete lack of such facilities than from the individual weaknesses of his ships that Cervera's squadron perished at Santiago, for his four cruisers would still have been able to play a good part if they had been active, if they had been provided with the things most essential to their life."

Naval bases are necessary in distant seas for the use and convenience of both fleets and armies, as seats for prize courts in time of war and as havens of refuge and refitment for merchant vessels. These bases must be protected from the fire of hostile ships and land forces. As to their defense, there is the one indispensable requirement that must be fulfilled, and that is, that they must have such natural advantages for defense that they may be securely held in time of war by their peacetime garrisons, as these garrisons can not be increased at the outbreak of war.

In the days of sailing ships, the base was almost non-essential. Six months stores were carried, and the base was necessary merely for powder, shot, and spars. Powder and shot, were, however, easily found anywhere and did not need frequent replenishing, while practically any forest would furnish spars. In the matter of spare sails any merchant ship could be commandeered; consequently a fleet was able to extemporize bases anywhere. Orthodox bases, at the same time, were easily defended and made impregnable and liable to no dangers save that of blockade. Base attacks were rarely if ever attempted later than the 17th century—practically they ceased to be made long before that

except in exceptional circumstances. Generally speaking, the base was impregnable.

When in war time, a battleship is temporarily rendered incapable of performing her functions as a first line-of-battle unit, it makes an immense difference to the fleet commander and to the operations on hand, whether she can be repaired at a distance of five hundred miles or of five thousand miles. The same is the case with minor repairs, and to a certain extent with the refueling problem, although the introduction of refueling an oil burner from a naval tanker has somewhat reduced this naval anxiety of recent years. For instance, it would be difficult to exaggerate the value of Guantanamo, only fifty miles from Santiago, to the American fleet off the latter port, which otherwise had to coal in the open or depend upon a base many hundred miles away.

Permanent bases should not be confounded with temporary or advanced bases seized for operations as near as possible to the center of the theater of war, usually on the enemy's coast, where for obvious reasons, it is impossible to establish permanent bases in time of peace. Thus, while Nelson's main base was at Gibraltar during his two-year watch of the French fleet at Toulon, he maintained an advance base at Magdalena Bay which enabled him to carry his operations close to his enemy and eventually contribute to his success at Trafalgar. The Japanese during their operations against Port Arthur, in spite of the proximity of the theater of war to the great permanent bases in Japan, used one or more advance bases, always referred to in their dispatches as a "certain place," as near as possible to the point of attack.

Permanent bases are points of departure from which an expedition may make a refreshed and final start for its objective; advance bases are points of rendezvous from which storeships and repair ships may assemble and minister to the needs of the fleet and where the fleet itself may lie while lookout or scout vessels keep in touch with the enemy's fleet. In selecting the site and planning the defenses of a permanent naval base, all possible powerful enemies in the indefinite and uncertain future must be considered; permanent bases must therefore be prepared to hold out against the tempest of destruction that may be brought to bear on them by enemies having temporary local command of the sea. Advance bases are selected for immediate use against a particular foe in a region where the command of the sea is assured; hence, extensive preparations against naval attack pure and simple or in combination with land forces are not required for advance bases. These bases are quickly and easily established with material kept in readiness in time of peace; and they are as readily abandoned when from necessity or a change of policy, the fleet withdraws.

The first objective in a war between two nations entirely separated by the sea is control of the sea, for the side that obtains such control secures immunity from invasion and, as a corollary, immediately gets the power to invade the enemy's territory. Until the control of the sea is determined, the land forces of the contending powers must play a subsidiary part. They can assist their respective navies most effectively by holding those naval bases and coaling stations that are essential to the service of their fleets in the contest with the enemy's fleets. Such in principle is the outline of the naval policy pursued by England for more than four centuries.

With the capture of Gibraltar in 1704, England began her system of strategic bases by which she has supported her dominion of the seas and of the fairest portions of the earth's surface. As this dominion grew, she dotted the face of the earth with naval bases which, together with her squadrons and her use of small oversea expeditions, have been the chief elements of her success. These bases have enabled her to make the enemy's waters rather than her own the theater of war, to treat the hostile coast strategically as the British frontier, and to hold the sea as territory which the enemy must be prevented from invading. Without this system of bases, which has given her most of the advantages of nearness to the scenes of great operations, her squadrons and her military forces would have afforded a very precarious strength.

The dependence of fleets upon naval bases is shown by the desire of belligerents, throughout the era of modern naval warfare, to fight near their bases. It is interesting to note that there has never been a great naval battle, or fleet action, in mid-ocean. The Dutch, in their three great naval wars with England, seldom "voluntarily engaged out of sight of their own coast." Nelson cautioned his captains not to be overbold in meeting the French, as he would let them alone until the shores of England were near. In the Russo-Japanese War, it was expected by many that Togo would attack Rojestvensky either in the North Sea, at Madagascar, at the entrance to the China Seas, or in the Formosan Straits. But the Japanese lay in wait at the passage of the Korean Straits in close proximity to their naval bases where their maximum means of action were available, as well as facilities for repair after battle.

It may be argued that with the greatly increased efficiency of steaming radius of action of a naval force, commanders of two contending fleets might be more free to seek action in mid-ocean than heretofore. A modern fighting force, due to its highly developed mechanical efficiency, requires a great deal more service and refitment from the

base than heretofore in the days of sail power; therefore, such forces are more than ever dependent upon their naval bases to keep up the fighting efficiency necessary. Thus, it may be expected in future naval wars, one force will seek to give battle under the most favorable circumstances to itself of proximity to its own naval base.

Strategic situation, that is, nearness to insular or transmarine dependencies, to probable theaters of war, or to trade routes, is, of course, a prime requisite for a naval base, but it is a common error to assume that any seaport fulfilling this requirement can easily be made to fulfill all others. A ship that has to go fifty miles to reach her field of operation will do in the course of a year the work of several ships that have to go five hundred. Fortified naval bases at suitable strategic points therefore increase numerical force by multiplying it, just as the possession of strategic points or the lay of the ground on a battlefield supply numerical deficiencies.

It may be said briefly that the strategic value of any position, be it a body of land, large or small, or a seaport, or a strait depends (1) upon situation (with reference chiefly to communications), (2) upon its strength, either inherent or acquired, and (3) upon its resources, natural or stored. As strength and resources are matters which man can accumulate where reasonable situation offers, whereas he cannot change the location of a place in itself, it is upon situation that attention must primarily be fixed. Strength and resources may be artificially supplied or increased, but it passes the power of man to move a port which lies outside the limits of strategic effort. Gibraltar in mid-ocean might have fourfold its present power, yet would be valueless in a military sense.

Moreover, it is a commonplace of strategy that passive positions, fortified places, however strong, although indispensable as supports to military operations, should not be held in great number. To do so wastes effective force. Similarly, in the study of a field of maritime operations, the number of available positions whose relative and combined influence on the whole is to be considered, should be narrowed by a process of gradual elimination to those clearly essential and representative.

Von Moltke's definition of a flank position is "a position taken up near and parallel to the enemy's line of operation—a position the enemy cannot pass without laying open his lines of communication." This definition can in a certain sense be applied to the location of naval bases with respect to possible enemies. The advantage of the flank position which England occupies with respect to Germany, either

through the Channel or around the north of Scotland, was clearly evident in the War.

It is asserted by some that fleets based upon naval bases flanking commercial routes command these routes more effectually than fortifications at narrow straits where these routes come to a focus: thus, that fleets based upon Aden and Malta would command the Red Sea route more effectually than fortifications on the Suez Canal, and that a fleet based upon Guantanamo is preferable to fortifications at the Panama Canal. But Guantanamo is a mainland position in so far as naval base desirability is concerned, and would require a large garrison in the absence of the fleet. A large fleet based on Guantanamo would prevent the use of the canal by the enemy's naval forces and commercial shipping, but it would be harmless to the enemy if the fleet were not kept in the Caribbean; the fortifications at the Canal will accomplish the same result without the use of the fleet which is therefore freed to carry its activities to other fields. We can reinforce the Canal from either side, the Atlantic and Pacific, for with the Canal in our possession, it is almost inconceivable that an enemy will be able to command both seas at one and the same time.

In times of profound peace, naval strategy in the unobjectionable form of peace strategy enables a nation to forestall the action of other countries in any given area, and, while enforcing its own policy, may make resistance or war inadvertent on the part of another country which may oppose such policy. Thus has the British Empire been consolidated.

For Great Britain, which in its wars with Napoleon had early become acquainted with the value of naval bases, the period of peace following the Napoleonic wars was the occasion of extending its possessions peaceably throughout the entire world, and thus mindful of the principle that naval strategy must also be prosecuted in peace, to provide herself with a line of communications to India, East Asia, and Australia. Particular activity was displayed in this respect, especially in the first period of the reign of Queen Victoria; Durban was occupied in 1838, Aden in 1839, New Zealand in 1840, and Hong Kong was acquired through the Opium War in 1842.

Ease of defense depends largely upon topography. Naval bases may be built on a bay of a continent or a large island, on a small peninsula, or on one or more islands of such limited extent of shore line that the enemy may be met at the water's edge and prevented from landing.

1. Of these positions, the most difficult to hold against a land attack is the position on the bay of a continent or large island, for the defense of the anchorage, the plant, and the coast defenses of a base so situated will require the occupation of a line from a few miles to forty or fifty miles long. Against such a place the enemy can carry on siege operations—bombardments from concealed batteries and in connection with infantry assaults. Few ports on the mainland were as well situated for defense as Port Arthur where the land front was only fourteen miles long. Bases have been selected on magnificent harbors on the mainland in recent times which would require a line of land defenses of more than forty miles.

2. A small peninsula, like Gibraltar or Tsing-tao, connected with the mainland by an isthmus is next in the scale of easy defense. The enemy, however, can still carry on regular siege operations against such a place though upon a more limited front. The defense of Gibraltar and of Fort Pickens illustrate the strength of well chosen positions on small peninsulas.

3. Islands upon which the enemy can be prevented from landing, such as Corregidor, Culebra, and the like, are easier to defend than positions on the mainland, since the best field of fire is a water area and the most easily defended position is a water front over which the enemy must advance in small boats. If the shores of this island are steep and barren, the task of the defenders is lessened; a few riflemen and machine gunners and an occasional field gun in addition to the regular seacoast armament will render them unassailable. Coral reefs and sunken rocks, if present, will add to the natural strength of the position and militate against the attacking force. History yields evidence of the excellence of such island positions in ancient times, such as Ravenna, Tyre, and Cyzicus, while in modern times, we have the illustration of the Confederate defense of Fort Sumter against a strong Federal fleet. Admiral Mahan sums up the advantages of island positions in his description of the island of Elba "so small as to be held readily by a few good troops, and having a port large enough, in Nelson's judgment, to harbor the British fleet with a little management." It should be remembered, however, that only a small portion of a nation's war fleet would ever really need to enter the harbor of a distant naval base at any one time.

The British base on the island of Malta in the Mediterranean is a splendid example of the inherent strength of a naval base situated on an island and by a great many authorities is considered superior to the far-famed Gibraltar, for the reason that it has no land frontier to protect and is therefore capable of much greater powers of self-defense. The harbor has splendid natural advantages for naval purposes; it is

not within range of adjacent islands that could be occupied by an enemy; its population is more than sufficient to provide an abundance of subsistence for the garrison in time of blockade or siege.

Island positions have been practically the only strongholds that have ever deserved to be called impregnable. Tyre, situated on an island one-half mile from the mainland, all but baffled the efforts of Alexander. Ravenna, surrounded by water and marshes, defied every attempt to take it for about 350 years and was taken, at least probably, through the treachery of the inhabitants. Mantua was taken by Napoleon only through famine. Cadiz, on the island of Leon, which is separated by three hundred yards of water from the continent, presented an undaunted front to Napoleon for three years. In our own Civil War, the Confederate forts situated on island at the mouth of Charleston harbor, separated by channels from one to two miles wide from other islands occupied by Federal troops, held out for three and a half years, until the final collapse of the Confederacy. Fort Sumter, an old masonry work on a small, well-defined island, was indeed reduced to ruins by Federal naval vessels and siege guns, but it was held to the last as an infantry position.

The best place for a naval base is a small island which fulfills the following conditions: (a) It should be on or near important trade routes; (b) it should be small enough so that a small garrison can prevent the enemy from landing; (c) it should have a commodious harbor sheltered from the fire of the enemy's naval vessels.

A distant naval base, if it is not to be a hostage to foreign powers, should be able to defend itself "for a reasonable time" without outside assistance; but a few writers of great influence and authority maintain that fortifications are not necessary and that the best defense for a naval base is the fleet itself. They say that the fleet can defend its own base tactically by its presence at the base, or strategically by its ability to appear upon the scene when necessity arises. These writers have made much of the fact that the nation having the superior navy almost invariably captures its opponent's bases. They ignore the self-evident truth that fleets and bases are both elements of sea power; that bases exist to increase the fleets' radius of action and are of no use to a nation without a fleet; that bases are fortified in order to give freedom of movement to the fleet and release it for its proper offensive work; and that a fleet by capturing a naval base may increase its own radius of action and decrease that of its opponents. To collect vast supplies of war materials at such places without providing tactically for their security is to labor for the enemy's benefit.

It is therefore an indispensable requirement for a distant naval base that its own inherent strength and susceptibility for defense shall be such that a relatively small garrison may render it impregnable to attack by land and sea. This may seem inconsistent with the requirement that the same base shall be able to hold out for "a reasonable time" without assistance from the fleet. The question of impregnability depends solely upon the ability of the defense to resist attack. A fortress that is impregnable may be forced to surrender for want of food or ammunition. There is therefore no inconsistency in saying that a naval base must at the same time be impregnable and be able to hold out for a "reasonable time."

Fortified places on land which can be vigorously assaulted can be taken; but the case bears a different aspect when the fortifications are upon islands which contain no civil population to exhaust the food supplies and can be attacked only by the long-range fire of artillery or by landing attack in boats under the defensive fire of infantry, artillery, and machine guns. Military text books teach us that the best protection for a position is a level, unobstructed field of fire over which the attacking force must pass to deliver an assault and that a plain is an ideal field of fire. The only perfect plains in nature are water areas. Islands are surrounded by ideal fields of fire. Hence, their great strength both in ancient and modern times.

Nature was kind enough to offer an almost ideal solution to the problem of the selection of a naval base in the Philippines when she placed Corregidor, Caballo, El Fraile, and Carabao at the mouth of Manila Bay. Military genius could not have improved upon the arrangement of islands and channels. The shores of these islands are, in general, high, precipitous, and unscalable; forests afford the best of concealment for the defenders; the channels can be mined and effectually covered by gun fire from the islands; the wide entrance will facilitate the deployment, in the face of an active enemy, of a fleet sailing from the harbor. These islands, it is true, will not secure the city of Manila absolute immunity from attack, but they do provide the greatest possible measure of protection by depriving the prize of the city of all its value to the enemy.

We may rest assured that there will always be a period in every war when the defense of our naval base in the Philippines will rest entirely in the hands of the army. This period will be followed by the arrival of a fleet capable of contending for the mastery of oriental waters, but this fleet on arrival must not find the base in the hands of the enemy. Until the fleet arrives, no reinforcements for the army can

reach the Philippines. Hence the conclusion is logical that our naval base there must be defended entirely by its peace garrison until the fleet arrives.

The enemy will no doubt rely on attack of a naval base, as early during hostilities as possible, by both aerial and naval bombardments. History fails to prove that any serious damage affecting the life of the defending forces had thus been inflicted, although practically every war brings forth the attempt on the part of the belligerent having at that time temporary control of the sea. It is true that the development of recent years in the use of airplane and the submarine mine have extended the depth of the defense zone in the immediate front of a naval base, and have thus in a certain sense held the attacking fleet outside of effective range of its guns. With the possible exception of a few detached efforts on both sides, and excepting the Gallipoli operations, there were no outstanding bombardments on either the part of the British or the Germans during the Great War. Long-range bombardments are harmless unless the fall of the shots can be observed and reported. The results of such bombardments at Port Arthur and during our own Spanish-American War were practically nil. The facilities composing a naval base are not distinctly large and vulnerable from the point of view of the attacking fleet. A direct hit on a dry dock or some of the shops composing the base would of course be a serious matter for the moment, but such damage is usually soon repaired under stress of war conditions, so that the damage is usually of a temporary nature. The storage of ammunition at the base can be safeguarded by the isolation of magazines from each other in order to localize damage. The problem of meeting an aerial attack on a navy base must be met with a properly disposed antiaircraft defense system of guns and auxiliary weapons that will keep enemy planes above effective bombing range.

The Japanese fleet under Togo made no less than eleven attacks or bombardments of Port Arthur between the beginning of February and the middle of May, 1904, some of these attacks taking the form of blocking operations in the attempt to bottle up the Russian fleet in the harbor by sinking large merchant steamers and lighters in the channels. In these successive efforts, carried out with great vigor by the Japanese, their main endeavor was to "lock up" the Russian fleet securely so that it would not interfere with the sea communications of the large Japanese expeditionary force. Their main bombardments, executed at ranges from 13,000 to 15,000 yards, produced no serious results. Mr. Jane makes the point that "a respect for tradition caused Togo to make the Port Arthur fleet his objective; but these much condemned bombard-

ments of his show that he also had a clear conception that, with the base destroyed, the fleet would matter nothing." In the course of all the operations, the Japanese battleships acted with the greatest prudence, and carefully avoided maneuvering in the area covered by the coast guns. They could not afford to risk the loss of several of their capital ships by pressing the attack close home, as much loss would have placed them at a great disadvantage and would have exposed them to the risk of ultimate inability to ward off disaster at the hands of the Russian Baltic Squadron one year later.

A long-range bombardment may be defined as an attack from below the horizon. As modern gun mountings on naval vessels permit of the high angle of elevation necessary to carry on a long-range bombardment, attacks of this kind against naval bases may be expected. Bombardments of this kind are absolutely aimless, and little likely to do harm save by a lucky shot unless continued for a considerable time at the cost of extensive waste of ammunition. A navy yard or dockyard, of course, covers considerable territory and that area can be accurately located by chart or aerial observation; it is a much more vulnerable target than a town and there is little or no comparison possible between the destructive effects of a large-calibered naval shell and those of the average shore guns when used against towns. One such shell dropped into a dockyard would, if it fell anywhere near shops, slips, or docks, do indescribable mischief. Neither the German or the English naval bases suffered to any great extent from bombardments at long range during the war, so it remains for the next war to prove the efficacy of this form of attack against naval bases.

In the remote times when ships were almost totally deficient in the quality of "sea endurance," navigation and naval wars were almost inconceivable without a compact chain of bases. The development of the type of ships which permitted fleets to cruise for longer periods at sea somewhat diminished the value of the fortified coast towns and allowed those towns to be placed further apart, until finally the modern steamship, with its great dependence on the replenishment of coal and navy yards, made the fortified naval bases absolutely the sinews of military power, without which a military operation either in a regular warfare or privateering for any length of time was inconceivable.

Secure anchorages but not capacious harbors are needed for distant naval bases. Such bases are not used by superior fleets as places of refuge, and should not thus be used by inferior forces. Finally, the abandonment of indefensible bases should not be postponed until foreign relations become unfriendly.

Conclusions to be drawn from the study of naval history lead to the strongly established belief that an indispensable requirement for a naval base, which shall be an element of strength instead of weakness, is that its own inherent strength and susceptibility for defense shall be such that a relatively small garrison may render it impregnable by land and sea, so that it shall not be dependent upon the fleet for protection but only for supplies and reinforcements at long intervals. Sound military policy demands that these permanent bases shall be few in number, strongly fortified and garrisoned, and well provided with ammunition and stores and facilities for refitment and repair. Inherent strength can not give importance to a place without strategic value; but a place without inherent strength can have no strategic value for permanent occupation.

The military argument for the selection and defense of naval bases amounts simply to this: that a moderate number of such bases, suitably chosen in view of their position and resources, strengthen a military or naval situation, and thereby enable fewer men or fewer ships to do the necessary work; but it must be at once qualified by the other perfectly familiar military maxim, that the multiplication of such bases, as soon as you pass the limits of reasonable necessity, becomes a source of weakness, multiplying exposed points and entailing division of force. It is not even a matter of indifference that you have too many; it is a positive injury.

#### MAXIM VIII

*A general-in-chief should ask himself frequently in the day, "What should I do if the enemy's army appeared now in my front, or on my right, or my left?" If he have any difficulty in answering these questions, his position is bad, and he should seek to remedy it.—Napoleon's Maxims of War.*

# Student Detail at M. I. T.

By CAPTAIN CLYDE L. WALKER, C. A. C.

OFFICERS who desire details as students at Massachusetts Institute of Technology, usually wish to prepare for a particular position or assignment. The more definite the objective, the easier it is to arrange a schedule.

The courses required by the office of the Chief of Coast Artillery are as follows:

Summer:

- M-72—Differential Equations (includes a review of Calculus)  
2.891—Applied Mechanics (The first part only of a course in Mechanics)

First Term:	Hours
6.501—Electrical Engineering Seminar	120
6.74—Electrical Engineering Lab. (Advanced Motor and Generator Lab.)	150
10.90—Experimental Research Problem (Chemical Engineering)	75
M.75—Exterior Ballistics	90
o.331—Electrical Communications Laboratory (Radio Laboratory)	105
Research (Thesis)	250

Second Term:

6.502—Electrical Engineering Seminar (Engineering Society)	120
M.54—Mathematical Laboratory (Graphical and Mechanical Computation)	120
10.90—Experimental Research Problems (Chemical Engineering)	120
6.282—Principles of Radio Communications (Elementary)	105
6.332—Electrical Communications Laboratory (Radio Laboratory)	105
Research (Thesis)	250

Premission may be obtained to change the above courses for good and sufficient reasons. The following courses are good and have been taken by officers in the past.

**COMMUNICATION DEPARTMENT**

- 6.302 Elementary Telegraphic and Radio Communications
- 6.312 Telephone Transmission Lines
- 6.561 Design and Application of Filters

**PHYSICS DEPARTMENT**

- 8.05 Sound Speech and Audition
- 8.06 Acoustics, Illumination and Color
- 8.07 Precision of Measurements
- 8.161 Aerial Photography
- 8.17 Geometrical Optics

**MATHEMATICS**

- 6.58 Operational Calculus
- M.36 Advanced Calculus
- M.26 Least Squares and Probability
- M.77 Vector Analysis

In the Civil Engineering Department there are several courses in Surveying, Railway and Highway Engineering from which to choose.

In the Mechanical Engineering Department are various courses in Automotive Engineering including the testing, design and operation of gas engines, that may interest Artillery officers.

**SUMMER COURSES**

The summer work is with the Ordnance Class and is similar to the work in the "Battery Officers Course" in which you work on one subject all day.

The differential equation course is excellent, but the benefit derived from the Mechanics course is of doubtful advantage, since it is not complete.

**THESIS AND SEMINAR**

The thesis subject should be selected early in the year, after careful thought and investigation.

It should be some project for the advancement of Coast Artillery Practice. Two officers may work on the same Thesis.

It will be easier if the Seminar paper is on some phase or closely related to the Thesis subject.

If three or four officers get together on a Seminar subject they can usually have it assigned to them.

### PREPARATION FOR THE COURSE

Some time can be spent to advantage on a review of Calculus before coming to Boston. Both differential and integral calculus are covered in two weeks, with a four hour examination on each, during that time.

A review of electrical units, hyperbolic functions, and alternating current theory, will also prove beneficial.

If the student can arrange to arrive at the beginning of the Summer term, about the 1st of June, there are many courses that may be taken either in review, or in preparation for the winter work. For those who arrive to begin work in July the Ordnance Course listed, is about the only one available.

### DEGREES

Most officers get a Master of Science degree but their courses must be arranged with this as an objective.

Credits from former Colleges and Service schools should be entered on proper forms and presented when registering.

### BOOKS AND STATIONERY

The usual stationery and supplies are furnished. Books must be purchased by the individual officer. They vary with the different courses and the cost ranges from twenty to fifty dollars per year.

### ORDERS

Most student officers are here on a temporary duty status, but all receive commutation of quarters.

### LIVING CONDITIONS

Rents are reasonable for a city and vary according to location. Furnished and unfurnished apartments near the school are available at rents ranging from \$40 to \$160 per month.

Unfurnished apartments two blocks from the school renting for \$75 a month are the most popular for small families. These apartments have living room, bedroom, dinette and kitchenette. They provide steam heat, electric refrigeration, janitor and elevator service.

Larger apartments are obtainable at an increasing scale of prices. Duplex houses farther away from the school, but much larger than the apartments may be had from \$50 up a month.

No Coast Artillery Officers have been able to draw furniture from the Corps Area or Fort Banks' Quartermasters this college year. The prospective student Officer's should either plan to rent a furnished house, bring, or prepare to buy the necessary furniture. This being

temporary duty, there is no allowance for packing and moving furniture.

Garages rent from five to fifteen dollars a month, the lower figure being the exception.

A car is useful for transportation but will not be used much for pleasure.

Servants are scarce. Their prices are as follows:

General Work ..... 50 cents per hour.

Half day maid, no cooking ..... \$6—\$8 per week.

Full time maid ..... \$15 per week.

The usual city laundries are available, with all types of service, all scale of charges.

There is a Commissary at Fort Banks, but is of little benefit to the student officers.

The work is hard and the hours are long but it is well worth the effort.



# Military Situation of Brazil

By CAPTAIN DON R. NORRIS, C. A. C.

THE military situation of Brazil is of importance to the United States and grows more so daily. Her geographical location and close proximity to the Panama Canal; her growing commerce, causing involved interests, and conflicts with outside nations; and her concessions to foreign governments, all tend to make Brazil an important factor as the ally of a power at war with us, as a friend and active ally of ours, or as a neutral.

The military situation depends to such a great extent on the geographical, political, and economic aspects that it is well to consider them first.

Brazil is the largest state in South America. It occupies the north and eastern part of the continent and has an area of over three and one-quarter million square miles, larger than continental United States, excluding Alaska. Its territory touches that of every South American nation except Chile and Ecuador and with each one there has been a boundary dispute at some stage in its political life. Spanish and Portuguese crowns attempted to define the limits between their colonies, and the lines adopted still serve in many cases to separate Brazil from her neighbors. Lack of information regarding the geographical features of the interior, however, led to some indefinite descriptions which have been fruitful sources of dispute ever since.

Brazil's land boundaries are remote from her centers of population, and this, with the natural character of the frontiers, constitutes barriers of great strength. The exceptions are the boundaries between Brazil and Uruguay, Paraguay, and Argentina. The frontiers here are open to invasion, but these boundaries, through wars, treaties, or arbitration, have been stabilized.

Brazil's seacoast of 4000 miles, about one-fourth the total of South America, has a number of important harbors at which expeditionary forces could land. The most important are Rio de Janeiro, Santos, and Rio Grande de Sul. Railroads connect these ports with centers of population and industry.

Brazil's strongest rival is Argentina, which is the only state strong enough, and through geographical location near enough, to become a menace.

Brazil was discovered in 1500 by Pinzon, one of Columbus' companions. In the same year, the Portuguese, landing further south, took

possession of the land, calling it Brazil from a wood producing a dye like the Indian dye of that character. The land was divided among favorites of the King, and to this day we find practically no government-owned land. This has been a serious obstacle in the development of the country. Brazil became an independent empire in 1822, and though there was some discontent and revolts, it is hardly fair to say that revolt is ingrained in the Brazilian people—they are, as a rule, peaceful, loyal, and law-abiding.

Brazil has had two wars—the first was with Argentina over Uruguay, and Brazil was the victor. The second was with Uruguay. In this war she was also the victor. These wars did much to test the patriotism and bravery of the Brazilian people and they learned many lessons in the military art of offense and defense. At the end of this war Brazil was prostrate with the loss of money and man-power. She faced this crisis bravely and no one can fail to admire her for her pluck and courage in restoring the national credit, and placing the country upon a secure industrial and commercial footing, all within a decade. Early in the 16th Century (1530) negro slaves were brought to Brazil to work the plantations, they taking the place of the fast disappearing native Indians. When the emancipation movement was agitating England and the United States, it was also at work in Brazil. While the Emperor was away in Europe, his daughter Isabel, made regent during his absence, signed the Emancipation Proclamation, freeing the slaves without remuneration to the owners. This antagonized the aristocratic land and slave holding class, who joined the republican cause and the Emperor was formally, but peacefully, deposed, and Brazil became a republic in 1889. After a rather hectic period of misgovernment Brazil has governed itself with decency and respect, and when we consider that the monarchy, after a bloodless fall, ceased to exist only 38 years ago; when with nearly as much at stake as there was with us, slavery was abolished without a struggle; and that after these two stupendous crises the country has reconstructed itself within the lifetime of one generation, criticism would be ill founded which could not find much to admire in these people.

The constitution of Brazil was patterned after that of the United States of America and was translated for them into Portuguese by one of our citizens, a resident in Brazil. It differs in some details, but seeks to preserve the vital features. The Roman Catholic Church is a powerful agent in spiritual affairs, but no church has organic relation to the nation. All religions are tolerated and are equal before the law. The foreigner is liberally treated in Brazil, and can exercise practically every privilege enjoyed by a citizen.

The Supreme Court is appointed for life by the president, there being fifteen members.

There are twenty-two states, whose independent relations make a less centralized government than our own. They have much more power than our states, so that state feeling is stronger than national spirit.

The educational problem has been a difficult one. Brazil has no university as we understand the term. The Department of the Interior does provide for higher studies in law, medicine, and technical training, but primary education is neglected, and the people as a whole are illiterate. In Brazil there is no color line, and when the Portuguese invaded Brazil they soon mixed with the Indian. Later when negro slaves were brought into the country, they united with the white stock and produced another strain. At the present time we find the Indian, the mestizo, and the whites. The natives generally are brave, but are ignorant and accustomed to following a leader. The mestizo is indolent and unstable, while the whites are accustomed to leading, but are often actuated by selfish motives.

We find, then, due to the diversity of races, their lack of education, her great size, and poor facilities for transportation and communication, Brazil lacks a strong spirit of nationality. It is only in some great crisis that this spirit can be aroused. She is one of the three leaders in South America and mainly on account of her much greater population, she could sustain a protracted war as well, or better, than the others.

There are no real political parties in Brazil, and no real internal political issues. Aside from her rivalry with Argentina for leadership in South America, Brazil has no foreign complication. She believes in arbitration and her attitude is pacific. She has joined the League of Nations and favors the Permanent Court of Justice.

Her relations with the United States have always been friendly and are becoming more so. She believes in and supports the Monroe Doctrine, and in case of trouble feels that she could rely on it for protection against a European or Asiatic power.

Brazil is essentially an agricultural country. Its prosperity depends upon the export of non-manufactured articles. This export trade is growing each year—in 1923 it was \$600,000,000. The material resources available for war include, in addition to such food products as coffee, sugar, cereals, and meat, industrial products such as hides, cotton, rubber, and manganese ore. Brazil is self-supporting in food stuffs, except wheat and flour, but this could be substituted for with corn and rice.

Although possessed of many raw materials necessary for peace or war time industry, practically all war requirements, except food stuffs, must be imported. At present, cotton textiles are the manufactures of importance. However, new life and industry have been introduced, and rapid strides are hoped for in the near future.

Brazil's railway communications are centered in the South. The main line is from Rio de Janeiro to Montevideo. This line, and its connections, is the strategic railroad. Roads and rolling stock are generally poor and service is limited to the vicinity of the large cities. Brazil's highways are very poor, with but comparatively few miles of paved roads. The postal and telegraph service is maintained by the government and is in only fair condition.

The Amazon River is an important commercial channel leading to the rubber country, but would not form a channel of invasion as it does not lead to vital areas.

Brazil's natural wealth and resources should make her financially sound, but her huge national debt, and the unskillful handling of her finances make her present condition very uncertain. The milreis is the Brazilian unit—its value is about 54 cents. It fluctuates at all times and there are daily quotations of its value. The money of Brazil is for the most part a paper currency. England is her largest creditor. In case of war of any magnitude Brazil would need foreign financial assistance.

Brazil's military system is based on compulsory service, both in peace and war. The president is the commander-in-chief of the Army; the administration is in the hands of the War Minister, while the highest commands are filled by division and brigadier generals.

The country is divided into seven military districts. These districts are of unequal extent and number of inhabitants, and as the distribution of troops to these districts is decidedly unequal, the effective strength in any emergency is greatly reduced.

The responsibility for the training, the discipline, and frontier protection rests with the division general for each district, and his task is very difficult.

Brazil passed a law in 1923 holding every Brazilian between 21 and 44 years of age liable for service. This service consists of two years with the colors; seven years in first-line reserve; seven years in second line reserve; and eight years in the militia. The strength of the Army in 1925 was 40,000, with a trained reserve of 69,000, and a first-line mobilization estimated at 500,000 officers and men. Brazil has a population of 31,000,000 and a man power of 1,200,000.

While Brazil has universal conscription, there are so many ex-

emptions and the law so feebly enforced, it is often necessary to build up the army by recruiting, and it is generally below strength. The training is not systematic, even for the first-line troops. The militia is hardly more than a paper organization, for the prescribed drills are not held. The officers are appointed from civil life without any training, and due to lack of supervision and control, service can be evaded at will.

Brazil also has a police force, armed and on a military footing, of over 26,000 men. This is a very efficient organization and could be used to advantage in case of need.

There are several military schools of importance from which the officer personnel is obtained. The German government placed twenty officers as instructors in the Brazilian Army and a French military mission from 1919 to 1925 effected improvement in discipline, armament, and efficiency. The air forces (Army and Navy) are being built up, and though small, are generally efficient.

The infantry is armed with the 7-mm, Mauser rifle, while the artillery, light and heavy, have Krupp cannon of various types and calibers.

Fortifications are few, and of little military value.

There is a general staff, with a chief of staff and four divisions similar to our G-1, G-2, G-3, and G-4. The country, being divided into regions or districts, has a skeleton division of the regular army stationed therein. In time of war it is planned that these divisions will expand to war strength by the addition of reserves living in the region in which the division is located. A division consists of two brigades of infantry, one brigade of artillery, a small regiment of cavalry, one battalion of engineers, an observation battalion of air service, communication, and transport troops.

The Navy has two battleships, two cruisers, three light cruisers, ten destroyers, three submarines, and various auxiliary vessels. A naval mission from the United States arrived in 1922, and under its guidance many administrative improvements were effected.

A war, individually or in combination against a hostile power of naval strength, would mean the complete bottling up and isolation of the country unless it had allies that could control the sea. Brazil is not capable of waging war outside of South America, and a war with even the weaker countries of that continent would be long drawn out, due in a large measure to the great distances between vital areas and to lack of communications. The roads, mostly dirt, are impassable in the rainy season, and very poor even in dry weather. In time of war, an invading force would have to depend upon animal transportation.

# The R. O. T. C.

*By MAJOR L. J. McNAIR, Field Artillery*

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It is natural and appropriate that the rising generation of young men should look up to those who carried the burdens in 1917 and 1918 and who are now rendering equally valuable service in making the National Defense a reality rather than a paper scheme. And, in turn, it is fit that the older men, who have given so much, should look not at the present alone but to the future as well; particularly should they concern themselves with the measures to provide replacements as the years roll on.

The Reserve Officers' Training Corps is the principal feeder of the Officers' Reserve Corps. The reserve officer who knows the R. O. T. C. can scarcely fail to appreciate it. The R. O. T. C. graduate of Purdue University has had some 830 hours of scheduled military training, both theoretical and practical, extending over four years and embracing every essential of the soldier and the officer. He has received this training during his most receptive years; he has absorbed it gradually, not by cramming; he has assimilated it and should retain it and enlarge upon it in sound fashion. In addition, he has engaged in a variety of military activities outside of scheduled hours. He has encountered the age old difficulties in handling men, he has learned which methods fail and which produce useful results; in other words, he has had practical training in leadership. Never before in our history have we produced officers so carefully schooled, except at the national academies. The full significance of the movement is yet to be felt and fully appreciated. To emphasize the matter, Purdue University is producing more artillery officers than any other one source, not excepting West Point; moreover, it is no exaggeration to state that they are more thoroughly grounded in artillery technique than are the graduates of that great institution, since the latter do not specialize until after graduation.

The older and higher officers who are shaping the affairs of the Organized Reserves are interested in this new young officer. They should know him and provide for his development. He should not be allowed to cease his military activities and rest upon any false idea of his own perfection. He leaves college full of enthusiasm for the Reserve; the Reserve must keep alive this enthusiasm.

While the Organized Reserves are the conventional channel into which the R. O. T. C. graduates flow, they should be considered equally available for the National Guard; indeed, a small number pass into the Regular Army, where they are found to make highly satisfactory officers. In utilizing the R. O. T. C. graduate, the National Guard supplies a basic need, namely, a source of officers who have had systematic training in their duties. The effort at Purdue University is to encourage the military graduate to enter the National Guard or the Organized Reserves, according to the amount of time he is able to devote to military affairs, the National Guard affording him the greater practical experience. Proselyting for the Regular Army is expressly avoided.

While the Reserve Officer, perhaps, is more interested in the output of the R. O. T. C. than in its internal processes, the R. O. T. C. as such needs the support of the Reserve in two particulars: First, against pacifists and their kind; second, in shaping public opinion so that adequate Congressional appropriations for the R. O. T. C. will be forthcoming.

As to the spasmodic attacks against the R. O. T. C. by pacifists, reds, pinks, chronic objectors, and publicity seeker, amateur and professional, the line of action is simple and clear: *inform the people*. Once the cloud of misinformation, exaggeration, and false logic is dissipated, there need be no fears as to the verdict of the great mass of Americans. The following points are mentioned by way of information and reminder:

Military training at colleges, either required or elective, is a matter of institutional policy. The War Department in no case invokes the Morrill Act or any other law to coerce the institutions.

The institution decides upon its course of action, based on educational considerations. Broadly, the student derives educational returns in the form of discipline during the first two years and leadership during the second two years.

Where military training is required in the basic course (freshman and sophomore), such action is quite consistent with the general policy of prescribing fixed curricula during the first two years. Other similar subjects are mathematics and English.

The Federal government is interested in military training for its military value; the institution seeks the educational return. Each agency achieves the object sought; hence the widespread success of the movement.

The assertion so often heard that institutions give military training because they are subsidized by the Government is absurd. Not only

does Purdue University receive no Federal funds on account of military training, but the Military Department costs the University *directly* over \$8000 per year, not to mention the indirect costs.

Military training at colleges is not inconsistent with our national scheme of voluntary service in peace. The student is in no way obligated to enter the military service in any of its components.

The item of Congressional support obviously is vital. The R. O. T. C. in the past has had the sympathetic support of the Congress; but, like many other activities, it has felt the pinch of the Budget. Not only have some retrenchments been necessary already, but other more pronounced ones loom formidably. The R. O. T. C. has reached its present proportions by means of current appropriations, strongly supplemented by large war stocks of materiel and equipment of all kinds. The conditions have given a false idea of the cost of the system. With the exhaustion of the war stocks, now imminent, the real cost will be clear. As a result, either the current appropriations must be increased greatly or the scope of the R. O. T. C. must be curtailed. In spite of the very proper considerations of economy, the actions taken by the Congress will depend largely upon public sentiment as to the value of the R. O. T. C.; if adequate support is in demand, it will be forthcoming.

All of us have encountered the apathy toward national defense which persists even if it does not prevail. There is tonic in the following quotations from the President of the University and from the students.

President Edward C. Elliott, January 28, 1926: "Here at Purdue University, the R. O. T. C. is regarded as an integral and valuable element in the plan of technical education, to which this institution is primarily devoted. However, entirely apart from the question of the specific training of men for reserve commissions, and entirely apart from the relation of the military training to engineering instruction, I consider that the R. O. T. C. contributes largely and efficiently to the development of those essential qualities of which dynamic character is composed—the sense of personal responsibility, the spirit of purposeful cooperation, the inspiration of leadership, and a recognition of the eternal place of order and organization in human society. Whatever may be its weaknesses, the R. O. T. C. is the one agency in the University in which civic service and relations are given a practical setting. While the course of training is immediately intended to qualify men for commissions in the reserve army, I have always considered that this training had an equally important aim of giving to the young men, who are fortunate enough to receive it, something in sharp contrast to the present day tendencies toward personal irresponsibility and lawless individuality; making them realize that strength of character

depended upon certain common realities of life rather than upon sentimental preachments."

Editorial, *Purdue Exponent*, student daily, November 11, 1927: "The annual observance of Armistice Day this morning occasions due compliments to the activity of the military department of the University. The true significance and worth of this branch of student life are overlooked by the average student. . . . We extend congratulations to the staff of regular army officers who supervise the activities of the corps, and to the corps as a whole for its never-ceasing interest in the general welfare of the University. We hope that such disgraceful actions as have been taken at the University of Wisconsin will never be instituted on this campus. Such actions would certainly never be tolerated. The work of the corps is too deeply appreciated ever to allow such procedures to occur. This evening will mark another milestone in the advancement of the corps. We hope that each of you realize its importance on this campus. It is an organization unique in itself—one of which we should feel duly proud."

#### MAXIM XIV

*Among mountains, a great number of positions are always to be found very strong in themselves, and which it is dangerous to attack. The character of this mode of warfare consists in occupying camps on the flanks or in the rear of the enemy, leaving him only the alternative of abandoning his position without fighting, to take up another in the rear, or to descend from it in order to attack you. In mountain warfare, the assailant has always the disadvantage; even in offensive warfare in the open field, the great secret consists in defensive combats, and in obliging the enemy to attack.—Napoleon's Maxims of War.*



COLONEL STEPHEN M. FOOTE

*Commandant Coast Artillery School, October 1, 1916—August 23, 1917*

# PROFESSIONAL NOTES

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## 243rd Coast Artillery (H. D.)

The Coat of Arms for the 243rd Coast Artillery (H. D.), Rhode Island National Guard, is:

*Shield:* Gules, over all and on saltire azure fimbriated argent a maple leaf of the last charged with a Rhode Island Red rooster proper; in dexter on a chief embattled of the third a pine tree vert.

*Crest:* That for the regiments of the Rhode Island National Guard: On a wreath of the colors (*argent* and *gules*) an anchor paleways *or*.

*Motto:* Game to the Last.

Under provisions of G. O. 8, Adjutant General, State of Rhode Island, 1923, all of the coast Artillery companies in the state were organized into a regiment and designated the 243rd Artillery (CAC), Rhode Island National Guard. In 1924 the designation of the regiment was changed to the 243rd Coast Artillery (H. D.), Rhode Island National Guard. The following is a brief history of the batteries of the regiment:

Battery E was chartered in the Rhode Island Militia in 1755 as "the Artillery Company" in the towns of Westerly and Charlestown. It was redesignated the "Washington Guards" in 1812 and again redesignated in 1855 as the Westerly Rifle Company. In 1873 the chartered company was extended into a battalion of two companies lettered A and B. B Company, Westerly Rifles, was, in 1875, redesignated as B Company, 3rd Battalion, Infantry, Rhode Island Militia. After other changes in the designation, the company, in 1917, was known as the 5th Company, C. A. C., R. I. N. G. The company was drafted into Federal service for the World War on August 5, 1917, and was redesignated the 19th Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in June, 1921, as the 5th Company, C. A. C., R. I. N. G. In 1922 the 5th Company was redesignated the 349th Company, C. A. C., R. I. N. G. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery E of that regiment.

Battery F was chartered in the Rhode Island Militia in 1774 as the Gloucester Light Infantry. In 1840 the designation of the company was changed to the Woonsocket Infantry. Its designation was again changed in 1842 to the Woonsocket Guards. In 1875 the Woonsocket Guards became Company A, 4th Battalion, Infantry, Rhode Island Militia. After other changes in designation, the company was known, in 1917, as the 12th Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service in the World War on August 5, 1917, and was redesignated the 12th Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in May, 1920, as the 12th Company, Coast Artillery Corps, Rhode Island National Guard. In 1921 it was redesignated the 6th Company, Coast Artillery Corps, and in 1922 the 350th

Company, Coast Artillery Corps, Rhode Island National Guard. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery F of that regiment.

Battery H was chartered in the Rhode Island Militia in 1774 as the North Providence Rangers. In 1824 its designation was changed to the Fayette Rifle Corps, and in 1857 to the Pawtucket Light Guard. In 1864 the company was changed into artillery and redesignated the "Tower Light Battery." In 1875 the battery was designated B Company, 1st Battalion Light Artillery, Rhode Island Militia. After other changes in designation, the company was known, in 1917, as the 8th Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service for the World War on August 5, 1917, and was designated the 22d Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in June, 1920, as the 8th Company, Coast Artillery Corps, Rhode Island National Guard. In 1922 it was redesignated the 352d Company, Coast Artillery Corps, Rhode Island National Guard. Upon the organization of the 243rd Artillery (CAC) in 1923, this company was designated Battery H of that regiment.

Battery A: The 1st Light Infantry Company in the 2d Regiment, Rhode Island Militia, was chartered in 1818. In 1842 the strength of the 1st Light Infantry Company was increased to 200 men. In 1872 it was expanded to a regiment of four companies lettered A, B, C, and D, and was designated the 1st Light Infantry Regiment. In 1875 Company A, 1st Light Infantry Regiment, was redesignated Company A, 1st Battalion Infantry, Rhode Island Militia. After other changes in designation, the company was known, in 1917, as the 1st Company, Coast Artillery Corps, Rhode Island National Guard. The Company was drafted into the Federal service for the World War on August 5, 1917, and was redesignated the 9th Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in May, 1920, as the 1st Company, Coast Artillery Corps, Rhode Island National Guard. In 1922 it was redesignated the 345th Company, Coast Artillery Corps, Rhode Island National Guard. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery A of that regiment.

Battery B: The 1st Light Infantry Company, in the 2d Regiment, Rhode Island Militia, was chartered in 1818. In 1842 the strength of the 1st Light Infantry Company was increased to 200 men. In 1872 it was expanded to a regiment of four companies lettered A, B, C, and D, and designated the 1st Light Infantry Regiment. In 1875 Company B, 1st Light Infantry Regiment was redesignated Company B, 1st Battalion Infantry, Rhode Island Militia. After other changes of designation, the company was known, in 1917, as the 2d Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service for the World War on August 15, 1917, and was redesignated the 28th Company, Coast Defenses of Boston, August 31 of the same year. It was disbanded in November, 1918. The company was reorganized in the state service in June, 1920, as the 2d Company, Coast Artillery Corps, Rhode Island National Guard. In 1922 it was redesignated the 346th Company, Coast Artillery Corps, Rhode Island National Guard. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery B of that regiment.

**Headquarters Battery:** The 1st Light Infantry Company in the 2d Regiment, Rhode Island Militia, was chartered in 1818. In 1842 the strength of the 1st Light Infantry Company was increased to 200 men. In 1872 it was expanded to a regiment of four companies lettered A, B, C, and D, and designated the 1st Light Infantry Regiment. In 1875 Company C, 1st Light Infantry Regiment, was redesignated Company C, 1st Battalion, Rhode Island Militia. After other changes in designation, the company was known, in 1917, as the 3rd Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service for the World War on August 5, 1917 and was redesignated the 10th Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service after the World War as the 3rd Company, Coast Artillery Corps, Rhode Island National Guard, and was redesignated the Headquarters Detachment, Coast Artillery Corps, Rhode Island National Guard, in 1921. Upon the organization of the 243rd Artillery (CAC), in 1923 the Headquarters Detachment was designated Headquarters Company of that regiment.

**Battery D:** The 1st Light Infantry Company in the 2d Regiment, Rhode Island Militia, was chartered in 1818. In 1842 the strength of the 1st Light Infantry Company was increased to 200 men. In 1872 it was expanded to a regiment of four companies lettered A, B, C, and D, and designated the 1st Light Infantry Regiment. In 1875 Company D of the 1st Light Infantry Regiment was redesignated Company D, 1st Battalion, Infantry, Rhode Island Militia. After other changes in designation, the company was known, in 1917, as the 4th Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service for the World War on August 5, 1917 and was redesignated the 13th Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in January, 1920, as the 4th Company, Coast Artillery Corps, Rhode Island National Guard, and was redesignated the 348th Company, Coast Artillery Corps, Rhode Island National Guard, in 1922. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery D of that regiment.

**Battery G** was chartered in the Rhode Island Militia in 1855 as the Mechanics Rifles. In 1870 its designation was changed to the Slocum Light Guard. In 1875 the company became Company B, 4th Battalion, Infantry, Rhode Island Militia. After other changes in designation, the company was known in 1917 as the 7th Company, Coast Artillery Corps, Rhode Island National Guard. The company was drafted into Federal service for the World War on August 5, 1917, and redesignated the 21st Company, Coast Defenses of Narragansett Bay, on August 31 of the same year. It was disbanded in December, 1918. The company was reorganized in the state service in January, 1920, as the 7th company, Coast Artillery Corps, Rhode Island National Guard, and was redesignated in 1922 as the 351st Company, Coast Artillery Corps, Rhode Island National Guard. Upon the organization of the 243rd Artillery in 1923 this company was designated Battery G of that regiment.

**Battery I** was organized in 1920 as the 16th Company, Coast Artillery Corps, Rhode Island National Guard. In 1921 it was redesignated the 3rd Company, Coast Artillery Corps, and in 1922 the 347th Company, Coast Artillery Corps, Rhode

Island National Guard. Upon the organization of the 243rd Artillery (CAC) in 1923 this company was designated Battery I of that regiment.

Battery C was organized in 1926 with its present designation.

The following is the war service of the various companies.

*Revolutionary War:* Pursuant to an act of the General Assembly of December, 1776, raising a brigade of two regiments of infantry and a regiment of artillery "for the defense of the United States in general and Rhode Island in particular," the artillery company (present Battery E) became the 2d Company, 1st Regiment of Infantry; the Gloucester Light Infantry (present Battery F) became the 5th Company, 1st Regiment; and the North Providence Rangers (present Battery H) became the 2d Company of the artillery regiment. These regiments were originally organized for 15 months but by subsequent acts of the General Assembly of Rhode Island they were maintained in the service until June, 1780. The entire service of these troops was in the State of Rhode Island.

The 1st Regiment was engaged in the Battle of Rhode Island, August 29, 1778. The artillery regiment was engaged in the Battle of Rhode Island, August 28, 1778, and in the affair with the British ship off Dutch Island in August, 1777. Upon the disbandment of the Rhode Island Brigade in 1780, these companies returned to their status as chartered companies in the Rhode Island Militia.

*War of 1812:* Battery E (Washington Guards), Battery F (Gloucester Light Infantry) and Battery H (North Providence Rangers) were in Federal service at Fort Adams, Rhode Island, between the following dates:

<i>Designation in Rhode Island Militia</i>	<i>Designation in Federal Service</i>	<i>Where served</i>	<i>Dates of service</i>
Washington Guards	Coe's Co., Wood's State Corps	Fort Adams, R. I.	July 25, 1814— Feb. 23, 1815
Gloucester Light Inf.	Gladding's Co., Wood's State Corps.	Ft. Wm. Henry, R. I.	Aug. 31, 1814— Feb. 23, 1815
North Providence Rangers	Wood's (Pearce's) Co., Woods State Corps	Fort Adams, R. I.	July 30, 1814— Feb. 23, 1815

These companies were not engaged in combat during the war of 1812.

*Civil War:* The 1st Light Infantry Company (Headquarters, A, B, and D Batteries) served as Companies C and D, 1st Rhode Island Detached Militia (1861—3 months); Battery E, Westerly Rifles, served as Company I of the same regiment. The 1st Rhode Island Detached Militia (1861—3 months) served in the Bull Run Campaign.

Under authority of their respective charters Battery G (Mechanics Rifles), Battery H (Pawtucket Guard), and Battery F (Woonsocket Guards) formed Companies B, F, and I, respectively, of the 2d Infantry, Rhode Island Volunteers. The regiment was mustered into Federal service in June, 1861, for three years but remained in Federal service until July 13, 1865. It served in the 4th and 6th Corps of the Army of the Potomac and participated in all of the campaign of that army from Bull Run to Appomattox. Upon being mustered out the personnel still remaining returned to their respective chartered companies.

*Spanish-American War:* During the Spanish-American War five of the batteries of the present regiment served as companies of the First Infantry, Rhode Island Volunteers, as follows.

<i>Present Designation</i>	<i>Designation, 1st Rhode Island Volunteers</i>
A Battery	A Company
B Battery	B Company
Hdq. Battery	C Company
E Battery	K Company
F Battery	D Company

The 1st Infantry, Rhode Island Volunteers, did not serve overseas in the Spanish-American War.

*World War:* During the World War eight batteries of the present regiment served as companies in Coast Defenses as follows:

<i>Present designation</i>	<i>Designation, United States Coast Defenses</i>
Hdq. Battery	10th Co., Narragansett Bay
A Battery	9th Co., Narragansett Bay
B Battery	28th Co., Boston
D Battery	13th Co., Narragansett Bay
E Battery	19th Co., Narragansett Bay
F Battery	12th Co., Narragansett Bay
G Battery	21st Co., Narragansett Bay
H Battery	22d Co., Narragansett Bay

None of these batteries served overseas as organizations, although a large part of their personnel was transferred to various coast artillery regiments.

Under the provisions of General Order Number 16, War Department, 1921, as amended, the 243rd Coast Artillery (H. D.), Rhode Island National Guard, is entitled to bear on its colors the following streamers with inscriptions as indicated:

*Revolutionary War*

Rhode Island, 1778

*War of 1812*

No inscription

*Civil War*

Bull Run	Wilderness
Peninsular	Spottsylvania
Antietam	Cold Harbor
Fredericksburg	District of Columbia
Chancellorsville	Petersburg
Gettysburg	Shenandoah
Virginia, 1863	Appomattox

The shield is red for artillery. The pine tree symbolizes service as New England troops during the Revolutionary War; the maple leaf represents service during the War of 1812; the blue saltire is for Civil War service (blue for the regiment's service as Infantry); the embattled chief represents the organization's service as Coast Defenses during the World War; and the Rhode Island Red rooster indicates the allocation of the regiment to the State of Rhode Island.

## The Proper Tactical Organization of a Harbor Defense

The essential tactical chain of command is:

1. Harbor Defense Commander
2. Groupment Commanders
3. Group (Gun and Mine) Commanders
4. Battery (Gun and Mine) Commanders.

A Fort Commander also is included as indicated below.

The Harbor defense commander controls all seaward, landward, and antiaircraft operations with which the command is charged. Where there is a single entrance to the harbor and this as well as the water approaches thereto can be controlled by one commander, the echelon of groupment commander may generally be omitted. Where there are two or more entrances, or where, for any reason it is necessary to group the armament, part for one normal zone and part for another normal zone, the action in each normal zone must be separately directed and it becomes necessary to appoint groupment commanders. Each is directly responsible for the seaward action in the area of his normal zone and for such landward defense as may be assigned him. He may or may not be charged with antiaircraft defense, depending generally upon whether or not the harbor defense is isolated. The action of groupment commanders is coordinated by the harbor defense commander who assigns to the armament of each groupment, as an eventual zone, so much of the normal zone of other groupments, as can be effectively covered by that armament.

Each groupment consists normally of a mine group and a number of gun groups.

To provide for the immediate defense of a fort against land attack and for the eventuality of loss of communication with other forts it is necessary to appoint, also, a fort commander for each fort, whose position in the normal tactical chain is dependent upon his command therein. Due to varying hydrography, and to the differing conditions existing as to terrain it is impracticable in many instances to emplace the armament and accessory installations so as to secure the most effective fire without sacrificing the desirable feature of having each fort commander in direct tactical control of all personnel, armament and accessory installations of his fort. A fort may contain only a single battery, or it may contain two or more batteries bearing on different water areas and hence assigned to different groups, or it may contain mine installations for mine fields controlled from another fort; in instances it contains all the elements of a groupment and again all installations of one groupment and part of those of another groupment. A fort commander may therefore be senior to the groupment commander, or he may be the junior of a groupment commander or even of a group commander. His position in the tactical chain therefore varies.

But he is and must be a tactical commander. In event of an engagement, such as a landing attack upon his fort, he must direct all personnel stationed thereat for the repulse of such attack, and, in event of loss of communication with other forts, he must direct the action of all elements located at his fort. It devolves upon the harbor defense commander to so organize the defense as to secure a smoothly operating machine. When practicable he stations his subordinates, in order of seniority so that the groupment commander will command also the most important fort of his groupment, and the group commander will command also

the fort containing the more important elements of his group. In instances it may be advisable, in order to secure unity of fort command, to sacrifice, to a degree, the ideal assignment of batteries to groups, depending upon the system of normal and eventual zones of fire to compensate for this disadvantage. When the fort commander commands a groupment or lower tactical unit in addition to his duties as a fort commander a separate fort command post is not necessary.

The above indicated organization is that essential for a large harbor defense and will of necessity require certain modifications based on local conditions for a harbor defense of smaller magnitude.

### French Antiaircraft Artillery

In addition to the flying troops are those set aside for group defenses. Principal among these troops is antiaircraft artillery (Défense Contre Aéronefs, or D. C. A.). Five regiments of artillery are set aside for this purpose. They are administered by the normal artillery authorities, but in operations they work closely with aircraft and are under the command of the general officer specially designated to control antiaircraft defense. The five regiments are organized and disposed as follows:

401e Régiment d'Artillerie: Headquarters, Hdqrs. *Peloton*; le Groupe, 75-mm. guns on motor car mountings, Romainville; 2e Groupe, 75-mm. guns on motor car mountings, Romainville; 3e Groupe, 75-mm. guns on trailers, Noisy; 4e Groupe, 75-mm. guns on travelling platforms, Rosny; 5e Groupe, searchlights, Rosny.

402e Régiment d'Artillerie: Headquarters, Hdqrs. *Peloton*; 1e, 2e, 3e, and 4e Groupes of 75-mm. guns, motor car mountings, and 5e Groupe of searchlights, Gonsenheim, Trier (Armée du Rhin).

403e Régiment d'Artillerie: Headquarters, Hdqrs. *Peloton* and le Groupe of 75-mm. guns on motor car mountings, Toul.; 2e Groupe, 75-mm. guns on motor car mountings, Metz; 3e Groupe, 75-mm. guns on trailers, Toul.; 4e Groupe, 75-mm. guns on travelling platforms, Toul.; 5e Groupe Mixte, two batteries of 75-mm. guns on travelling platforms and two companies of searchlights, Metz.

404e Régiment d'Artillerie: Headquarters, Hdqs. *Peloton*, le and 2e Groupes of 75-mm. guns on motor car mountings, Dijon; 3e Groupe, 75-mm. guns on trailers, Dijon; 4e Groupe, 75-mm. guns on travelling platforms, Dijon; 5e Groupe, searchlights, Dijon.

405e Régiment d'Artillerie: Headquarters, Hdqrs. *Peloton*, le and 2e Groupes of 75-mm. guns on motor car mountings, Sathonay; 3e Groupe, 75-mm. guns on trailers, Sathonay; 4e Groupe, 75-mm. guns on travelling platforms, Sathonay; 5e Groupe, searchlights, Sathonay.

Note: Each Groupe consists of three batteries each of four guns.—*The Army, Navy and Air Force Gazette*.

### The Prieur Automatic Corrector for Antiaircraft Fire

Translated from *Revue D'Artillerie*

The object of this pointing corrector is to construct a line of sight for the eye which, when directed on the objective, will mechanically apply the corrections for antiaircraft fire, that is:

a. The correction for the displacement of the airplane during the time of flight.

b. The correction for elevation corresponding to the distance to the plane.

*Principle of the device.*—Let A be the position of the airplane at the instant of the departure of the projectile from the gun O; let B be the position of the plane at the moment the projectile reaches it; let T equal the time of flight of the projectile; let D equal the distance AO; let V be the speed of the plane in air.

The vector AB will then have a value equal to the product VT.

Let us further assume Oa equal to a constant length K; then if we draw a line from a opposite in direction to AB, we have:

$$ab = KV \frac{T}{D}$$

The angle of correction sought could then be mechanically reproduced by constructing the triangle Oab in which the side ab is parallel to the path of the plane and has a value proportional to the product

$$V \frac{T}{D}$$

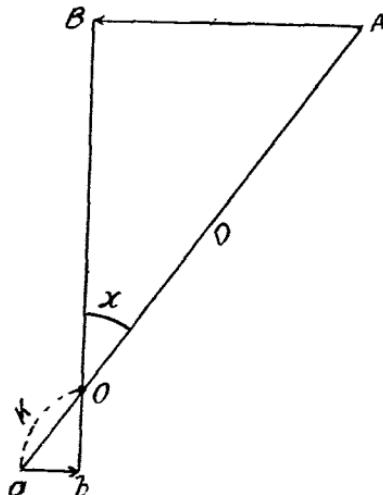


FIG. 1

The corrector is a mechanical construction of the triangle Oab. It thus provides the correction for displacement of the target in three dimensions: height, vertical deflection, and lateral deflection.

The correction of the elevation corresponding to the position of the target is based on the principle of the vertical elevation, which is as follows:

For a range D and any position of the target, the elevation H, that is, the elevation of the front sight notch above the axis of the gun, the line of sight being considered of invariable length, is obtained by using vertically the value

that gives that same elevation in horizontal fire. The apparatus limits itself to solving the equation  $H=f(D)$ , the site angle being then introduced automatically by simply pointing at the target.

pointing at the target.

*Description of the Corrector.*—The corrector consists of three principal parts:

- a. The support fastened to the cradle of the machine gun.
- b. The telescopic sight carried by the support and connected to it by an inserted joint.
- c. The corrector (plateau-but), a kind of calculating box, mounted pendulum fashion above the cradle, which controls the telescopic sight by means of a system of connecting rods and links.

A connecting rod, fixed at one end on the gun mount and at the other end on the corrector (plateau-but), keeps it vertical, no matter what may be the inclination of the cradle.

On the corrector (plateau-but), three mechanical devices combine the corrections for distance, speed, and direction of the target and give to the sight the correct setting with respect to the axis of the gun. These three devices are:

a. The arrow which is pointed parallel to the line of flight of the plane, the point toward the propeller whether the plane flies horizontally, in a curve, or up and down. The movement of the arrow introduces in the corrector (plateau-but) the element "direction location of the target in a horizontal plane" and the element "correction for the vertical speed of the plane" (up and down flight, curved flight). The pointing arrow up and down or obliquely introduces automatically into the value of the horizontal speed of the target, the increase or decrease due to the inclination of the bearing of the target in the horizontal plane.

b. The elevation wheel that carries an index of which the upper part is marked with the ranges from 500 to 3500 meters.

The operation of this elevation wheel introduces in the corrector (plateau-but) the element "distance to the target": it serves at the same time, to indicate a quantity proportional to the vertical elevation for the range used, i. e. superelevation.

c. The speed of the hand gear that directs the drum upon which are engraved curves corresponding to the rate of the speed of the target (from zero to 300 km. per hour) and which should be attached to the edge of the elevation index.

The operation of this hand wheel introduces into the corrector (plateau-but) the element "horizontal speed of the target."

When the different elements of fire are correctly placed, the principal rod of the pointing cone produces the direction to give to the line of sight indicated by a clear collimation.

The support of the collimator can be displaced in height and direction in such a way as to permit the regulation of the adjustment of the sight for different weapons.

This adjustment allows a coincident setting on the same distant point, first by means of the line of open sight and second by means of the collimator.

### British Naval Materiel

*H. M. Ships Nelson and Rodney.*—On August 15, the battleship *Nelson* was commissioned at Portsmouth with a full crew for service in the Atlantic Fleet, and after being docked during September joined the Fleet on October 14, hoisting

the flag of Vice-Admiral the Hon. Sir Hubert Brand, the Commander-in-Chief, on October 21, in succession to the *Revenge*. On August 10 the *Rodney* was commissioned at Birkenhead for trials with a special Devonport complement.

*The Kent Class.*—The first of the new 10,000-ton cruisers, *Suffolk* and *Cornwall*, were commissioned on September 21 and October 3, respectively, at Portsmouth and Devonport, for further trials. The revised dates for their completion are mid-January, 1928, and the end of November, 1927, respectively. The *Berwick* (Fairfield Company) was commissioned at Devonport, with a special two-fifths complement, on July 12 and completed to full crew on November 1 to replace the *Despatch* in the Fifth Cruiser Squadron, China. The *Cumberland* (Vickers, Ltd.) began her trials in September, and is due for completion in November. The *Kent* (Chatham Dockyard) will not be finished until February, 1928.

*Launch of H. M. Ships London and Devonshire.*—The *London*, the first of the four ships in the second group of 10,000-ton cruisers, authorized on 1925, was launched on September 14 at Portsmouth, when the Lady Mayoress of London performed the naming ceremony. Her first keel-plate was laid on February 23, 1926. No details are yet available concerning the ship, but it is understood that the length is 590 ft., and that the armament will include 8-in. and twenty smaller guns, with eight torpedo tubes. The design has a high freeboard, lack of sheer forward, and absence of flare. The ship will be flush decked, and carry two light masts without platforms or tops, the control and observation positions being arranged in the bridge structures. There is no side armor, but a 4-in. curved protective deck and the customary armored shafts to protect the ammunition hoists. Parson's geared turbines driving four screws, and supplied with steam from Yarrow oil-fired boilers, are designed to develop 90,000 S. H. P., giving a sea speed of from 31½ to 32 knots. The machinery is being manufactured by the Fairfield Shipbuilding and Engineering Co., Ltd.

*The Devonshire*, laid down at Devonport on March 16, 1926, was launched on Saturday, October 22, by Lady Mildmay of Flete. Messrs. Vickers, Ltd., are providing the machinery of this vessel.

*H. M. S. Dorsetshire laid down.*—The first keel-plate of H. M. S. *Dorsetshire*, the first of the three cruisers of the 1926 program, was laid at Portsmouth Dockyard on Wednesday, September 21, on the slip from which the *London* was launched a week earlier. The ceremony of lowering the plate was performed by Mrs. Donaldson, wife of the Admiral-Superintendent.

*New Minesweepers.*—On September 17, contracts were announced with Messrs. Hawlhorn Leslie and Co., of Hebburn-on-Tyne, for two minesweepers of a new design, provided for in the current Navy Estimates. These ships take the place of four motor launches which had originally been planned for 1926. They are of an experimental type, combining the merits of the old sloops and minesweepers in one.

*Reserve Destroyer Organization.*—On July 19, it was announced that between thirty and forty destroyers in reserve at the southern ports and at Port Edgar were to be sent to Rosyth and kept there in maintenance reserve.—*The Journal of the Royal United Service Institution.*

## Application of Photography on a Moving Film for the Measurement of the Initial Velocity and the Study of the Motion of Projectiles

Translated from *Rivista Marittima* by COLONEL FRANK E. HARRIS, C. A. C.

The measurement of the initial velocity is a regular operation at the proving grounds of the Royal Army and Navy. The data devised serve for the construction of firing tables, calibration of lots of powder, etc.

The well-known system of measuring the initial velocity with the Le Boulengé Chronograph is generally used in firing which is practically horizontal; but this system is not applicable when firings are executed at angles greater than  $25^\circ$  to  $30^\circ$ , owing to the difficulty of setting up and maintaining the screens at considerable heights. To give an idea of the practically insurmountable difficulty of employing this system, it suffices to point out that the second screen must be about 160 meters above the ground for a projectile fired with an elevation of  $45^\circ$  at 800 meters from the screen.

M. G. Foex, in the January *Journal de Physique*, describes his system whereby he has succeeded in measuring the velocity of projectiles fired under any elevation,

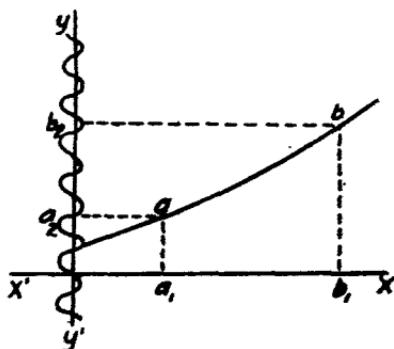


Fig. 1

with a precision comparable to that given by the screens. The basic idea of the method consists in photographing the projectile on a film moving perpendicularly to the direction of the trajectory.

The image of the projectile on the film moving with a velocity  $v$  describes an arc which is practically coincident with a section of the right line  $xx'$ , (fig. 1). The film, with nearly uniform motion, moves in the direction  $yy'$ , perpendicular to  $xx'$ , with a velocity  $w$ , adjustable at will to conform to the velocity  $v$ . The image of the projectile thus describes on the film a path resulting from the composition of the two motions  $v$  and  $w$ , at right angles to each other. If these motions were uniform the path would be a straight line inclined to the axis  $xx'$  at an angle such that:

$$\tan \alpha = \frac{w}{v}$$

As the motion of the film is not uniform, we will generally have a curve. A section of such curve  $ab$  gives the projection  $a_1 b_1$  on the axis  $xx'$ , which is proportional to the space passed over by the projectile from A to B along its trajectory. The linear scale on the film is determined by direct measurement, by photographing, with the film at rest, a base of known length perpendicular to the optical axis and located at the same distance from the machine as the trajectory. The ordinate  $a_2 b_2$  represents the length of film displaced in the time the projectile moves from A to B. The value of this ordinate can be directly determined in units of time if care is taken to record the vibrations parallel to  $xx'$  of a standard tuning fork on the film. The vibrations recorded under the form of a sine curve parallel to the axis  $yy'$  permits of graduating the latter axis in units of time. Hence the time taken by the projectile in traversing an arc AB of known length, can be directly measured on the film.

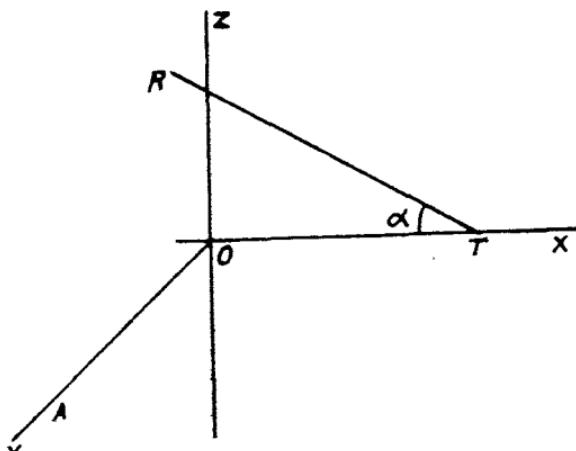


Fig. 2.

In order that the method may be applicable to firing conditions, it is essential that an instrument, set up with the optical axis normal to the trajectory, shall be capable of photographing, in broad daylight, a projectile endowed with a velocity which may reach or can exceed 1000 meters per second.

The photographic problem has been solved by successive trials with heights of aperture from 2 to 10 times that of the expected image. The speed of the film varies from 60 centimeters to 4 meters per second. The trace of the projectile is thus quite clear. The photograph in Figure 3 was obtained with height of aperture of 2 mm., diameter of image of .4 mm., and W 1.7 meters per second.

Let us now examine the problem of aiming the optical axis of the objective. Let  $xoy$  (fig. 2) be the horizontal plane containing the optical center of the machine A, and let  $xoz$  be the plane of fire and  $yoz$  the plane perpendicular to it and containing the point A. The elevation  $\alpha$  is known, the distance OA and OT are accurately measured.

In order to aim the machine the author starts upon these initial positions: optical axis horizontal and contained in the plane  $yoz$ , aperture horizontal. The camera is given an azimuth angle  $A$  such that (plane  $yox$ )

$$\tan A = \frac{OT}{OA} \sin^2 \alpha.$$

and as site angle  $\sigma$  (plane  $xoz$ )

$$\tan \sigma = \cot \alpha \sin A.$$

To make the aperture parallel to the trajectory, it will suffice to incline the camera to the plane  $yoz$  by an angle  $T$ , such that

$$\cos T \cos \alpha \cos A.$$

However, the set of operations necessary to obtain a most exact set-up is not at all simple. It may be compared to those necessary for setting a theodolite up over a station.

The most difficult of all the operations is that of making the aperture parallel to the trajectory. The failure to attain this result may be due to error of aiming of the gun or of the machine or both; but chiefly upon the jump of the piece before the shot leaves the bore.

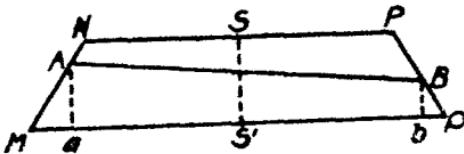


Fig. 3

This angle may attain a value of  $20'$ , and varies from shot to shot. To eliminate the errors arising from these various causes the aperture has the form of an isosceles trapezium with the shorter sides inclined at  $45^\circ$ . The trace AB left on the film by the projectile is limited by the points A and B, at which the image of the projectile intersects the shorter sides of the trapezium.

If the aperture is correctly oriented, the points A and B are equally distant from the axis of symmetry SS'; otherwise, by measuring the distances S'A and S'B, we have all the elements for determining the obliquity of the trajectory with respect to the aperture.

When the aiming of the gun and machine is accurate, the angle which the trace of the trajectory makes with the longer sides of the trapezium is equal to the jump.

In order to record the time upon the moving film, an electrically operated tuning fork may be used, in which case the tuning fork must be set vibrating some time before the shot is fired. However, the electric tuning fork is not reliable for the reason that its operation depends on the constancy of the exciting current. The author thinks it preferable to replace the electric tuning fork by the ordinary type which may be set vibrating by hand shortly before firing the shot.

The machine completely set up is shown in figs 4 and 5.

The movement of the film carrier takes place by the expansion of a limited volume of compressed nitrogen acting on two pistons forming part of the carrier. The nitrogen reservoir and the two expansion cylinders are clearly visible in the figures at the top of the machine. By varying the pressure of expansion in the cylinders we may obtain velocities up to 5 meters per second. The aiming mechanism has a cradle and a fixed base. The cradle has a rotary motion around a horizontal axis and one around a vertical axis with respect to the base. They



FIG. 4

permit of placing the optical axis perpendicular to the trajectory.

The camera has a motion of rotation around the optical axis with respect to the cradle.

The machine also permits of photographing projectiles in motion. For this purpose the film must move parallel to the image of the projectile. If it moves with the same velocity as the projectile, the resulting photograph will be quite distinct and clear and may reveal the behavior of the projectile along the trajectory.

The machine also permits of observing any portion of the phenomena of the departure of the projectile from the muzzle of the piece and of the movement

then produced on the gases of the combustion of the charge. In order to make this photograph the aperture is set up parallel to the trajectory and the movement of the film is perpendicular to that of the projectile.

An examination shows an emission of slightly luminous gas preceding the exit of the projectile; immediately afterwards the flow becomes an incandescent jet whose luminosity is diminished. Later, a new incandescence appears, due to a re-inflammation of the gases of the charge mixed with air; the flame formed may present quite a length and last some time.

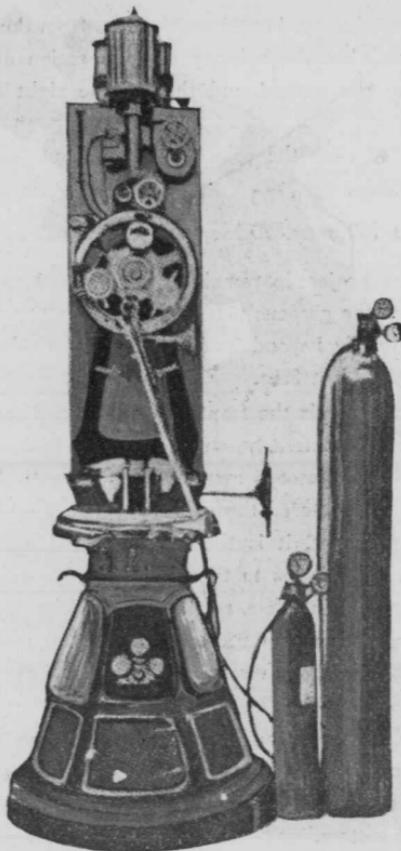


FIG. 5

The projectile, however, leaves the moving gaseous column very rapidly. It is considered of great interest to set down completely the description of the phenomena accompanying the firing a 305-mm. shot derived by direct observation made with the machine by Kampé de Feriet in the Memorial de l'Artillerie Française 1925 (Vol. IV).

Before the projectile left the muzzle (about 0.0015 seconds) slightly luminous gas issued and was propagated with a speed of about 300 meters per second.

The projectile having left the muzzle in the tube-like formation between the

muzzle and the base of the projectile, the gases rushed outward with an enormous lateral velocity of expansion (about 2000 meters per second).

When the base was slightly beyond the muzzle the gases acquired a forward velocity of expansion of the order of 1400 meters per second. This velocity being greater than that of the projectile (720 meters per second), the gaseous mass passed the projectile and completely enveloped it. After 0.001 seconds from the exit of the projectile, the gaseous mass, almost wholly unilluminated, presents the appearance of a flattened pumpkin extending to 1.4 meters in front and 2 meters to right and left.

The projectile, whose base is but 70 centimeters from the muzzle, is completely surrounded by the gases, but the velocity of propagation of the forward face is reduced to 1000 meters per second and that of the right and left sides to 780 meters per second.

At equal intervals of time the velocity of the front face rapidly diminishes.

Time (sec.)	0.002	0.003	0.004	0.005	0.007	0.009
V (meters per sec.)	730	580	470	370	320	310

The velocity of the projectile remaining nearly 720 reaches the front face, perforates it, issues from the gaseous mass and after about 0.007 seconds, 5 meters from the muzzle, is definitely beyond its influence. The velocity of the side faces decreases like that of the front face.

At the end of 0.025 seconds the front face is about 9 meters from the muzzle and the side faces about 8 meters, when a grandiose phenomenon is manifested. After leaving the muzzle the gaseous mass was almost entirely dark, with perhaps a few incandescent points scattered through the mass. Suddenly, the whole mass becomes violently incandescent, it is the beginning of the true explosion which is called reinflammation. This gives to the velocity of propagation of the gaseous mass a clear and unexpected increase, so that the velocity of the front face passes from 120 meters per second after 0.025 seconds to 160 meters per second after  $t=0.035$  seconds, to 180 meters after  $t=0.045$  seconds, after which the velocity slowly decreases.

The incandescence of the gaseous mass lasts some time in the air; at the end of 0.15 seconds the flame is still dazzling, the gaseous mass continues to expand slowly, the front face attains the distance of about 20 meters from the muzzle, the side faces about 10 meters.

The projectile having reached about 5 meters in front of the gaseous mass, its motion can no longer be distorted by the powerful whirlpools which must be produced in the midst of the burning gases.

The photographs show deformations of fixed objects placed in the field of the objective. This deformation is assumed due to a refraction of the light rays through the muzzle wave of the gun. The images are deformed along a curve, and from an examination of this curvature may be deduced the velocity of propagation of this wave near the origin. At 15 meters from the muzzle of a 305-mm. gun it has been found to be 1460 meters per second, which corresponds to a pressure of 2 Kg. per square centimeter.

## Seventeenth Century Ordnance

<i>Names</i>	<i>Caliber in inches</i>	<i>Diameter of Projectile</i>	<i>Circumference of the shot in inches</i>	<i>Weight of corn powder</i>	<i>Weight of the shot in pounds</i>	<i>Weight of the piece in pounds</i>	<i>Length of the piece in feet</i>	<i>Point blank range, in paces</i>	<i>Maximum range, in paces</i>
Canon of	8	7½	64	25	32	8000	12	300	1500
Canon Serpentine	7½	6¾	52	23½	26	7000	11½	340	1600
French Canon	7¼	7	46¾	22¾	23¼	6500	12	360	1740
Demi-Canon eldest	6¾	6½	36¾	21¼	20	6000	11¼	370	1800
Demi-Canon Ord	6½	6¼	32	20½	18	5600	10½	350	1700
Demi-Canon	6	5¾	24½	19	16	5000	11	340	1600
Culverin	5½	5¼	19	17¼	15	4500	13¼	420	2100
Ordinary Culverin	5¼	5	16¾	16½	12½	4300	12	400	2000
Demi-Culverin	4½	4¼	11¾	14	9	3000	11	380	1800
Demi-Culverin lesse	4¼	4	9	13½	7½	2300	10	320	1600
Saker ordinary	3¾	3½	5¼	11¾	5	1900	9½	300	1500
Sakeret or Minion	3¼	3	3¾	10¼	3½	1100	8	280	1400
Fawcon	2¾	2½	2¼	8¾	2½	750	7	260	1200
Fawconet	2½	2	1	7	1½	400	6	220	1000
Rabinet	1½	1¼	¾	3½	½	300	5½	150	700
Base	1¼	1	¼	3	¼	200	4½	100	560

The weapons given in the table were those most usual in England. There were also in use:

	<i>Caliber</i> <i>inches</i>	<i>Projectile</i>	<i>Corn Powder</i>
		<i>lbs.</i>	<i>lbs.</i>
Canon of	10	174	136
Canon of	11	205	146
Canon of	12	245	162
Canon of	13	285	190
Canon of	14	348	232

Since standardization had not attained the perfection of today, there was much variation from normal in the manufacture of weapons. All of the cannon given in the table appeared in heavier and in lighter forms. Other guns, varying in length or in diameter were termed Bastard pieces by the gunners of the day. The ordinary basiliske was a bastard double-culverin (a 48-pounder) with a maximum range of 3511 paces. The serpentine was a bastard culverin (24-pounder); the aspike, a bastard demi-culverin (12-pounder); the pelican, a bastard quarter-culverin (6-pounder). There were also bastard falcons, rabinets, and bases.

## French Naval Retrenchment

Suggestions recently that France is doing less than she might in regard to retrenchment in armaments are by no means borne out by the facts. Her Navy has been reduced 50 per cent in tonnage since the war, and Rochefort Dockyard, the closing of which was decided upon over a year ago, has now passed into the hands of a private concern, who have undertaken to keep as many of the old workmen as possible employed under their auspices. Figures issued by the Foreign Office in Paris show that in 1920 the French forces were reduced 20 per cent as compared with 1914; in 1925, a reduction of 14 per cent had taken place as compared with 1920; and the present reorganization of the French Army will result in a further reduction of 18 per cent as compared with 1925.—*The Army, Navy and Air Force Gazette.*

### MAXIM XI

*To direct operations with lines far removed from each other, and without communications, is to commit a fault which always gives birth to a second. The detached column has only its orders for the first day. Its operations on the following day depend upon what may have happened to the main body. Thus this column either loses time upon emergency, in waiting for orders, or it will act without them, and at hazard. Let it therefore be held as a principle, that an army should always keep its columns so united as to prevent the enemy from passing between them with impunity. Whenever, for particular reasons, this principle is departed from, the detached corps should be independent in their operations. They should move toward a point fixed upon for their future junction. They should advance without hesitating, and without waiting for fresh orders; and every precaution should be taken to prevent an attack upon them in detail.—Napoleon's Maxims of War.*

# BOOK REVIEWS

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*Gentleman Johnny Burgoyne.* By F. J. Hudleston. Bobbs-Merrill Company. 1927.  
5½" x 8¾". 367 pp. Ill. \$5.00.

A pleasant and very readable life of General Burgoyne, dedicated to "those who won" as well as to "those who lost the Battle of Saratoga," and with rancor towards none save Lord George Germain. The author does not claim that Burgoyne was a great general, but that "he loved his profession, and his soldiers loved him. He always gave his men the credit due to them, a little formality which some great generals of the past have neglected. . . . There never has been in British military history a soldier so shockingly let down by the minister at home, because there never has been in military history a war minister so casual, so incompetent, so mean, so contemptible, so cowardly as 'that man' (Germain)."

Hudleston makes out a good case for Burgoyne so far as his advance on Saratoga goes. He shows that Burgoyne had strong grounds to justify his contention that his orders to join Howe at Albany left him no choice but to advance, even though that point of view might now seem rather pedantic. And of course he harps on the fact that Germain altogether neglected to give Howe similar orders to join Burgoyne. So "Gentleman Johnny," with his bull-dog chin, plunged ahead. The rest was pretty much inevitable, the actual credit for the surrounding of Burgoyne's army and the forced "capitulation" which followed being due, as Hudleston clearly states, to Schuyler and Arnold.

The chapters on our treatment of the British prisoners after Saratoga do not make pleasant reading. The times were rough, but even so we were certainly lacking in chivalry, to say the least. And in the delayed expatriation of the prisoners the Continental Congress cut in pretty close to the shady side of the deal. But, as Hudleston remarks, "Anglo-Saxons do not make good prisoners of war. . . . They do their best to make it as unpleasant as they possibly can for those who have taken them captive."

The book has much more substance to it than the author's *Warriors In Undress*, and is of general interest to all military men.—S. M.

*Field Marshal Sir Henry Wilson.* By Major General Sir C. E. Callwell. Charles Scribner's Sons. 1927. 2 Vol. \$10.00.

A diarist, who sometimes wrote as much as 1300 words a night in the midst of the war, who was never out of touch with the inner workings of inter-allied command (save when he led an army corps), and who withal was a sprightly Irishman fearing neither man nor devil, such a one must have written things worth reading. And he did. The pity of it is that it had to be expurgated!

The voluminous diaries of Sir Henry Wilson, running from 1893 to his death in 1922, are edited, commented upon, and strung together into a continuous story by Major General Sir C. E. Callwell. Wilson could hardly have had a better literary executor than this soldier-author and sympathetic friend. The resulting two volumes are the most vigorous, incisive, and scintillating commentaries which have yet appeared on the war. Almost day by day one sees that struggle and its

directing statesmen, generals, and admirals projected in sharp silhouette against the fiery blast of Wilson's passionate convictions. A prejudiced point of view, yes—partial to the last degree: but never does it fail to be clear-cut, vivid, and sincere. Again and again this book forces from the reader Wilson's own ejaculation—"Whew!"

The old saying that the best general is he who makes the least mistakes suggests that all generals make them. Certainly Wilson did. We who are gifted with hind-sight can easily pick them out in his diaries, many and many of them. He was, for instance, wrong in opposing Kitchener's policy in 1914 of building up an army for a long war. He was wrong in his apparent indifference to new inventions, such as the tank, and in his stubborn conviction that the way to win the war lay in "killing boche" by man-power on the Western Front. Or else he was wrong in his later swing towards Easternism when he advocated shifting troops from France to Turkey in the winter months. He was wrong in his persistent efforts to break up the American Army, and in his exaggerated statements as late as October, 1918, that we were not giving "full value" and were "unfit to fight" as an army.

Even less pardonable than his errors in judgment was his attitude towards some of his superiors. Driven hard by the intensity of his convictions and blinded by his egotism, he sometimes verged on downright disloyalty to his own chiefs. When he was Chief Liaison Officer with the French he permitted Joffre to say to him that the British strategists "were fools," and adds, "I told him I cordially agreed with him." During the armistice, while Chief of the Imperial General Staff, his contempt for civil authorities, including the entire British Cabinet, was outspoken and almost unbounded—he had no use for "the frocks," as he called them. And when the Irish crisis came, his opposition to the policy of his own government led him to the extreme of advising an Ulster leader how "to smash the conference" by means of which his own chief was then seeking peace.

All this is far from being admirable. The other side of the story is that vivid, glowing personality, that keen humor and brilliant (if not always perfectly balanced) intellect, that talent for incisive and forceful estimates of situations and clear-cut decisions, that driving power of work and will which carried Henry Wilson through those discouraging years of preparation for war, through the war itself, and through the almost equally trying period which followed it. This man, rising during the war from sub-chief of the general staff of the Expeditionary Force to Field Marshal and Chief of the Imperial General Staff, was in the end described by Lloyd George, his chief but not his friend, as "never daunted . . . calm, courageous, . . . full of fortitude." As he himself said of another, he was "a good gun in a crisis."

His great work lay in his making it possible for the British Expeditionary Force to take the field promptly in 1914, complete and fully equipped; in his outstanding influence in holding together the highly centrifugal forces of Allied Higher Command—British, French, and later Italian (and what a job that was!); and finally in his pre-eminent part in the establishment of the Supreme War Council, which later resulted in unity of command. These were his great contributions to Allied success, and on them his fame securely rests.—S. M.

*Everyman's Guide to Radio, Vol. I.* Edited by Raymond Francis Yates, Popular Radio, Inc., New York. 1927. 5"x 7½". Ill. \$4.00.

As a guide to the unscientific individual who desires a working knowledge of radio, this book presents in an excellent manner the theory underlying radio. While the authors have frequently resorted to the use of analogies in the picturing and explanation of radio phenomena, such analogies are carefully chosen, and are, as a rule, surprisingly exact.

A chapter on "Diagrams—the Shorthand of Radio" presents the conventional diagrams of "wiring sketches" for comparison with photographs of the apparatus designated. This presentation makes it possible for the uninitiated to picture readily a wiring diagram in its full meaning.

For those who would compute rapidly, and to a satisfactorily approximate value, the terms desired in the construction of radio sets, a very complete set of curves and nomographic charts is presented, and the use of these curves and charts is fully explained.

The step-by-step explanation of the methods of receiving radio impulses and of the sets used in their reception is satisfactory in the extreme.

For those who desire an elementary reference on radio requiring no previous scientific training this book is to be recommended.—G. H. B.

*Lefax Radio Handbook.* By Dr. J. H. Dellinginger. Revised with the cooperation of Mr. W. H. Shirk. Lefax, Inc., Philadelphia. 1927. 4¾"x 7". 213 pp. Ill. \$3.50.

This is the "7th loose-leaf edition" of a book which was extremely popular amongst radio enthusiasts in the earlier editions. The standing of the author is a guarantee of the reliability and accuracy of the book. The subjects which are treated include: What Radio Does, Fundamental Principles, Elements of Receiving and Transmitting Apparatus, Assembly of Receiving Sets, Operation of Receiving Sets and Their Accessories, Antennas, Radio Data, and Index.

While the contents must of necessity be largely a repetition of former editions, comparison shows careful revision, and its up-to-dateness is shown by the fact that it describes—and gives circuits for—the new A. C. tubes, and a complete list of Broadcasting stations, which is as nearly correct as is possible while so many changes are being made by the Radio Commission.

Concise directions are given for the construction of many standard circuits; and circuit diagrams, panel layouts, and baseboard arrangements are given in each case. The six-ring, loose-leaf style of binder permits of adding notes and making rearrangements and corrections of the text. It is believed that this book will be a worth-while addition to the library of the radio fan as well as the student and set builder.—W. R. S.

*Biography: The Literature of Personality.* By James C. Johnston. The Century Company. 1927. 5¼"x 7½". 312 pp. Ill. \$2.50.

This little book is an essay on all forms of biography, and contains an interesting chapter of "The Marks and Indications of the Souls of Men." Various classical examples of biography in different ages are discussed. Perhaps the most useful part of the book are the lists of biographies of various kinds and times.—S. M.

*The Story of Everest.* By Captain John Noel. Little, Brown and Company, Boston. 1927. 5½"x 8½". 258 pp. Ill. \$4.00.

The unknown, or hitherto unattained, has always held up to man the beckoning challenge of increased knowledge or adventure. The recital of trips into the unknown, whether of science, discovery, or imagination, has ever enticed man to a desire to read or listen, in order that he might, in part at least, duplicate in fancy the experiences of the participants.

When, during the year of 1852, "the Bengali Chief Computer rushed into the room of Surveyor General, Sir Andrew Waugh, breathlessly saying, 'Sir, I have discovered the highest mountain in the world,'" man had placed before him another peak of attainment, the conquering of which would further augment his puny knowledge of the world in which he lives.

But "the highest mountain in the world" was many miles from the points where it had been observed, and beyond a territory unknown and hostile to those who had discovered this giant of mountains. The fact that computations showed the peak to have an elevation of twenty-nine thousand one hundred and forty-five feet above sea-level, rather than terrifying man, lured him on in attempt after attempt to set foot upon this, the highest possible goal of those who would rise and still remain earth-bound.

Captain Noel, official photographer of successive attempts to set foot upon the summit of this "new" mountain, Mount Everest, most graphically describes the expeditions of 1913, 1922, and 1924 in his book which he has chosen to call "*The Story of Everest.*"

Praise of the attempts of pioneers in any field fails in comparison with the deeds themselves. Suffice it to say that the stories of the journeys from Darjeeling to Everest, the description of strange lands through which these explorers passed, the tales of dwellers in the high places at the foot of Everest, and last but by no means least, the stirring recital of man's attempt to surmount the obstacles of a new environment in an altitude greater than ever before attempted by him, together with the problems of sustaining himself, miles from his base of supplies, in a country whose peoples looked upon his attempt as a sacrilege to their gods, present an interest not found in most books obtainable at the present time.

The illustrations, of which the book contains many, add a color and interest not attainable by the written word alone.—G. H. B.

#### MAXIM IX

*The strength of an army, like the power in mechanics, is estimated by multiplying the mass by the rapidity; a rapid march augments the morale of an army, and increases its means of victory. Press on!—Napoleon's Maxims of War.*